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... CONTENTS ...

	PAGE
Objectives as Determining Factors for Making a Course of Study for Junior and Senior High Schools. *Zay Barber*	1
The Contribution of Slides and Films to Science Teaching. *Paul L. Müller*	13
Lightning Rods a Real Protection	17
The Pronunciation and Spelling of Words Used in Science. *Duane Roller*	18
Modern Lathes. *Edwin Seaver*	29
The Earmarks of a Good Science Teacher. *Elliott R. Downing*	34
Motion Pictures in the Teaching of Junior High School Science. *J. T. Shriner*	40
The Science Teacher. *W. G. Whitman*	47
Surface of Mars Like Desert Mountain Tops	50
What Makes Water Flow Uphill	52
Climatological Records May Be Depended Upon	53
The Part Drier Plays in Paint	54
How to Make a Record of a Lightning Stroke	55
Available Motion Picture Films	56
Book Reviews	60
Science Articles in Current Periodicals	66
Magazine List	70

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Objectives as Determining Factors for Making a Course of Study in Junior High School Science

By ZAY BARBER, University of California.

[Chapter II and all but one paragraph of the introductory chapter of this thesis have been omitted because they deal with generalities concerning the Junior High School. That part of the thesis which deals with the specific application of these to a science course is given in this article.—EDITOR.]

INTRODUCTION.

IN preparing and organizing the material presented here, a study was first made of the junior high school, particularly with the thought of finding what its aims and functions are. The aims of science teaching in the junior high school were next ascertained by bringing together the various aims stated by different authorities. These aims were compared with the aims of science teaching in the senior high schools, to find what differences there were in the two. In this connection the place that science now holds and the extent to which, and the success with which, it is being taught in the junior high schools in the United States were also considered. Next curriculum construction and course of study making were studied to obtain a foundation on which to rest the actual work of making a course of study for junior high school science. And finally the principles developed were applied concretely to show a method of procedure that a course of study group might follow.

III.

THE NATURE OF JUNIOR HIGH SCHOOL SCIENCE.

Before approaching a discussion of the course of study in science for the junior high school, it is necessary to consider what the objectives of the subject are, and what purpose the different topics introduced may serve in bringing about a realization of these objectives.

Recently, especially since the close of the World War, the

teaching of science in elementary schools has received much attention and support. This is due to the fact that a great many children end their school life at the close of the junior high school, or before, and cannot be allowed to approach their practical and social lives, in so scientific an age as this, without having had some of the wonders of modern science revealed to them. It is also because of the belief of educators that junior high school subjects should be large over-views of a whole field rather than detailed or close study of a specialized part of a subject. Science lends itself particularly well to this view, as it is not difficult to find many simple topics that can be presented without the use of any abstract principles.

In preparing courses of study for elementary science, individuals and committees have differed widely as to the subject matter that should be included, the grade in which a certain subject should be taught, and even as to the aim of the teaching of science. However, since the publication, in 1920, of the report of the Committee for the Reorganization of Science for Secondary Schools, most of the courses prepared have followed the suggestions of the committee.

Referring to general science, that report says:

The subject matter of general science should be selected to a large extent from the environment. It will, therefore, vary greatly in different communities. The science involved in normal human activities and especially the science involved in the reconstruction period after the war, presents many real problems which must be met more intelligently than formerly if there is to be the needed increase in effectiveness of the service which individuals and groups are expected to give. Science is universal and constant in the life of our citizens, and hence, to be useful to all pupils, general science must accept the science of common things as its legitimate field. The science of common use and that of the class room should be the same. General science should use any phase of any special science which is pertinent in the citizen's interpretation of a worthwhile problem.

The particular units of study should be those that truly interest the pupils. Interest not only secures productive attention, but is an evidence of attention. To be substantial educationally, interest must rest upon a sense of value, an evident worthwhileness in the topics considered.

No topic should be selected which is meager in content or lacking in significant problems. The range of material which can be used is in reality limited only by the capacity, experiences, and needs of the pupils. The materials should be concrete and capable

of leading to many avenues of new and untried experiences. . . . . Topics should be large units. At the outset the topic should be viewed briefly as a whole, for the sake of perspective. Such a general view gives a concrete and significant basis to which there should be constant return and to which further and more detailed and more exact studies should be constantly related.

For the biology course the commission gave the following aims:

Biological science, in common with the other sciences in secondary schools, should contribute to the educational objectives,—health, worthy home membership, vocation, citizenship, the worthy use of leisure, and ethical character. In particular, biological science should have the following specific aims:

(1) The world war has emphasized health as a basic end of education. Since much of biology deals directly with the problems of health, the course in biology must accept efficient health instruction as one of its chief and specific ends.

(2) The biological sciences should develop the pupil's purposeful interest in the life of the environment by giving a first-hand acquaintance with plant and animal neighbors.

(3) They should emphasize some of the most important applications of biological science to human activities and to general and individual human welfare, and especially should familiarize the pupil with the structure and functions of his own body, to the end that he may know why he must live healthfully in order to live happily and usefully.

(4) They should train the pupil to observe life phenomena accurately and to form logical conclusions through the solution of problems and through projects essential to the productive work of agriculture and gardening, etc.

(5) They should enrich the life of the pupil through the aesthetic appeal of plants and animals studied, to the end that he may appreciate and enjoy nature.

(6) They should demonstrate to the pupil the value of intensive study of biological science as a means through which scientific progress is attained. In view of what science has meant to our present-day civilization, and in view of the measure in which the methods and results of scientific investigation are today reflected in intelligent thought and intelligent action, the need of the life sciences in the education of modern citizens cannot be ignored.

This report is the work of fifty science teachers and is based on the best practices then in use. Yet, even in so short a time as five years since the report was issued, new ideas have been advanced concerning the aims of elementary science. Dr. Otis W. Caldwell writes:

Since the report was issued, the types of courses and sequence advocated have become fairly common. Nevertheless, limitation in available time of pupils in which they may take science, and limitation in availability of teachers with desired preparation, have probably prevented many pupils from securing as much instruction in science, or the kinds of instruction, thought desirable. Furthermore, the failure of the content, method and organization or science courses to respond to the most pertinent needs of modern social, industrial and aesthetic uses is thought to have kept some of the objectives of the report from being as widely realized as was expected.[1]

Dr. Holland R. Sperry, of Lincoln School, Teachers' College, New York City, at the 1924 meeting of the National Education Association discussed his beliefs as to what science should do for the individual, as based on his own observations in the class room. He said:

It should develop in him a scientific attitude, one that is receptive of changes. It should give him a greater appreciation of his environment—a liking for it—an active positive attitude to do something about it, and a realization of what science and a scientific attitude have meant to modern progressive life. It is difficult for the classroom teacher to keep in mind and try to achieve all the special aims or objectives claimed for science. It would be far better to teach science in such a way that we would satisfy the general education aims. Better still, we should provide science activities which, when properly carried out, would, in their very nature, lead to the accomplishment of our objectives. When the opportunity presents itself to develop any of these aims, stress it and make the most of it, whether it is in the first grade or sixth—whether we are studying the weather or magnets.[2]

W. L. Eikenberry, in "The teaching of general science," writes:

It appears then that the primary aim in science teaching is: (1) to instruct the pupil in that scientific knowledge which is valuable as a preparation for life-activities, (2) to use this knowledge and the processes of its acquisition in disciplining the mind in the scientific method, and (3) to impart an insight into nature and organization of the environment, so far as time and the limitations of mind permit; secondarily, to use the materials of the course to train in right habits and to develop desirable ideals, tastes and appreciations.

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1 Caldwell, Otis W. Plan of the American Association for the Advancement of Science to study "The Place of Science in Education." School and Society, vol. 20, p. 535, Oct. 1924.

2 Journal of the N. E. A. vol. 14, Jan. 1925, p. 26.

In summarizing the objectives of general science, Eikenberry says:

It is the mission of general science to explain to the pupils those natural phenomena that have interest and significance for them, and to impart to them such additional knowledge as their interests and needs demand; to encourage the pupils to solve the simpler problems themselves as a beginning of scientific thinking; and to develop such easily comprehended principles as apply to the local environment and the pupils' interests. Secondary aims, conditioned by local circumstances, will include the mastery of particular scientific facts and principles useful as a preparation for economic-vocational activities, training in important habits, mastery of underlying principles preparatory to later science work, the encouragement of recreative interests, and the creation of social-civic ideals.[3]

In "Junior High School Curricula," Dr. H. C. Hines writes:

To understand what unit courses would need to be simplified and included in a general course in natural science, it is necessary to understand what considerations have led to the development of such a course. First, for junior high school pupils, or for beginning pupils in senior high school, an introductory course is needed that not only will explain the natural phenomena but will lay the foundation for further scientific study. Second, there has been practically no opportunity for the pupil to gain a knowledge of science unless he entered a laboratory class in a unit course. Third, as in such studies as community civics, household physics, or household chemistry, there is need for a course in science that will relate natural phenomena to the activities of life as the child will later find them.[4]

From these quotations it is clear that the kind of science courses that are needed for the junior high schools are very different from the usual courses in botany, biology, physics or chemistry, and are by no means to be made up merely of parts of these sciences adapted to the mind of the junior high school pupil.

At the Cincinnati meeting of the American Association for the Advancement of Science, in 1923, a committee was appointed, with Dr. Otis W. Caldwell as chairman, to study the place of science in education. Writing of the plan of the committee in an article in *School and Society* for October 25, 1924, Dr. Caldwell says:

3 Eikenberry, W. L. The Teaching of General Science, pp. 49 and 65.
4 Hines, H. C. Junior high school curricula, ch. 5.

The committee wishes to formulate an adequately descriptive statement of the purposes and plans now used in American education, and of aims and improvements that seem worthy of serious consideration. This movement has originated from the thought that the unprecedented recent development of the sciences, and the rapid introduction of scientific knowledge and scientific thinking into everyday life make it highly desirable that such a statement should be formulated, to hasten the spread of a general understanding of the functions of science in modern education.

One of the things that the report will deal with, Dr. Caldwell says, is the "proper popularizing and socializing of science knowledge." The same idea is expressed by Dr. Edwin Slosson of Science Service, Washington, D. C., in an article in *School and Society* for April 6, 1924. He calls it "re-introducing the human element" in order to interest the un-scientific mind of either children or adults. "What needs to be brought out is how a single scientific discovery may transform everyday life, industrial conditions, international affairs, and the prevailing mode of thinking."[5]

Dr. Slosson favors the elementary science course that is an over-view of the field of science, giving two apt illustrations.

When the tourist comes into a strange city, he generally takes the first opportunity to ascend the highest building in the place, the Washington Monument, the Woolworth Building, the Eiffel Tower, or the Venetian Campanile, to get a bird's-eye view of the whole city, before he begins its study in detail. It cannot be denied that such a preliminary survey may correctly be called superficial. From such a height nothing is distinct and much is hazy.

If general science is to retain an honored and useful place in the schools, it must maintain its own point of view, which is as legitimate as that of the several sciences. It is simply a question of the method of attack. There are two ways of cutting up a jelly-cake. One is horizontally,—take off layer by layer from top to bottom. The other is to cut down perpendicularly through all the layers. You get just as much cake in the latter case as the former, and even a thin slice from top to bottom gives you a better knowledge of what the cake consists of than you get from the most thorough mastication of a single layer. "A little knowledge is a dangerous thing" only when what little is known is inaccurate, indefinite, or over-estimated.

A plant does not belong to botany exclusively. It belongs as

5 Slosson, Edwin E. Science teaching in a democracy. School and Society, vol. 19, p. 383, April 5, 1924.

well to physics, to chemistry, to astronomy, to meteorology, to dietetics, to aesthetics, and to other sciences too numerous to mention. All of the sciences have an indirect interest in the living plant, but if any one tries selfishly to separate its share all it gets is a lifeless abstraction.

So it seems to me advisable to give our pupils a glimpse of nature in its wholeness before we begin to partition it among the several sciences.

The early years of adolescence are the period of sweeping generalizations, of cosmical theorizing, of wild speculation, of unbounded ambition.

It is particularly important that the growing child get the vitamine of generalization.

These quotations give the main thought of Dr. Slosson's article. They show the kind of course that is needed for the junior high schools, as distinguished from the specialized sciences of the senior high school. The search for statements of aims for junior high school science shows that many educators have the same or similar ideas. VanDenburg, in his book "The Junior High School Idea," gives his view of the aims of the subject:

We should, through general science, teach our pupils to be better able to use, intelligently and economically, the products of science. We should teach them to depend less upon the hired specialists in workaday science, because each pupil will have himself the knowledge that formerly only the skilled worked possessed. We should open to each junior high school pupil's mind the possibility of taking some part in the world of science, as a worker in that field, but should not attempt to give even a rudimentary beginning of that training.

Franklin K. Bobbitt, in "How to Make a Curriculum," says that the science training should aim at developing lifelong interests, attitudes, appreciations, and mental alertness in the presence of innumerable things, as fully as it aims at science knowledge. "For the general training, extensity of vision, interests, and appreciations is more important than the intensity and accuracy appropriate to the research specialist and the several vocational fields involving applied science."

The following list of the aims of science teaching has been made by listing all of the aims stated by various authorities—those quoted here and others—and then striking out those that were duplicates and combining those where the meaning was clearly the same. Even so, there is considerable overlapping of aims as given in the list. It is not intended that this list

of aims should be adopted by a course of study making group. Such a group may find suggestions in the list, but should develop its own list of aims for the course. This list is general, not specific, or for any one grade of the junior high school.

AIMS OF SCIENCE TEACHING.

To train in laws of health and personal hygiene.
To teach how to use the products of science intelligently and economically.
To give the scientific knowledge necessary in preparation for life activities.
To discipline the mind in the scientific method of thinking.
To learn to solve simple scientific problems.
To depend less upon hired specialists in workaday science.
To stamp out superstition and fake.
To interpret personal life.
To learn to generalize.
To understand the achievements of science.
To interpret the social environment.
To get an over-view of the field of science.
To create proper social-civic ideals.
To learn to see things and relations clearly and accurately.
To develop easily-comprehended scientific theories.
To enjoy pure science.
To gain aesthetic, intellectual and moral benefit of scientific training.
To explore the child's interests, aptitudes and capacities.
To lay the foundation for further scientific study.
To develop interest in and appreciation of nature.
To learn to use and enjoy the products of science.
To encourage recreative interests.
To give practice in the experimental processes by which scientific principles are discovered and established.
To explain natural phenomena.
To gain practical advantage through science.
To reveal the possibilities in the major fields of science.
To interpret American industrial life.
To show the possibilities of being a worker in the field of science.
To give a mastery of scientific facts useful for later economic vocational-activities.
To learn through science, order, economy, foresight, efficiency, and the frank facing of facts.
To train in right habits and develop desirable ideals, tastes and appreciations.

If Briggs' statement of the fundamental purposes is recalled, "To explore by material in itself worth while, the interests,

aptitudes and capacities of the pupils, and to reveal to them by material otherwise justifiable, the possibilities of the major fields of learning," it will be noticed that many of the aims of science for junior high schools are direct steps toward the realization of these fundamental purposes. Thus, while revealing to him the possibilities of being a worker in the field of science, while teaching him to perform simple mechanical repairs about the home, and while giving him a mastery of scientific facts useful for later economic-vocational activities, we are really exploring his interests, aptitudes and capacities. In explaining natural phenomena and simple scientific theories, and in giving an over-view of the field of science, we are revealing to the pupil one of the major fields of learning.

IV.

The Status of Science in the Junior High Schools.

When the junior high schools were first established, the general tendency was to give general science in the ninth grade, as it had been a ninth grade subject in the four-year high schools. Later, the materials of general science were spread out somewhat and a course made that would cover two years of work. Health instruction, which had been gaining great headway in the schools, was made a part of the science work later, and the physiology combined with it for a seventh grade science course.[6] That there is at present great need of revision of science courses for junior high schools is made clear in the study by James M. Glass on Curriculum practice in the junior high school and in grades five and six.

Mr. Glass' investigation covers fourteen centers in various parts of the United States and reveals a very chaotic condition, as far as any well established practice as to what science should be taught and in what grade of the junior high school, is concerned. He found a relatively large amount of time being devoted to instruction in health. Much of the work in hygiene and physiology is of a practical type, and much of it, on the other hand, is of a distinctly scientific type. In the latter respect health instruction supplements the sciences.

The content of courses of study in science at the present will be shown later in the summaries that are given of courses of

6 Hines, H. C. Junior High School Curricula, ch. 5.

study from different places. Examination of text books in general science will also reveal what material is being used, as many of them are built around some course of study, and many of them are adopted and used in place of a course of study.

One of the things that the course of study makers must guard against, that is brought out by Mr. Glass, is the overlapping of departments, or lack of co-operation between departments, especially in the matter of health instruction. Mr. Glass says:[7]

> In nearly all the centers there is confusion regarding the responsibility for health instruction, or more strictly speaking for hygiene instruction. This work is being given by health teachers, science teachers, and social studies teachers. Certain phases of health instruction may properly be delegated to each of these groups of teachers. Frequently, however, the practice of delegating to several people the duty of teaching hygiene results in a loss of instructional time, because of the lack of clear distinction in the division of instructional materials. The situation might be more effectively administered if the responsibility for the proper articulation of health teaching by the three groups of teachers were definitely assigned to a health director.
>
> It is suggested that a suitable division might be for the teachers of social studies to handle the welfare work, clinics, playgrounds, parks, etc., and health as a public, home and personal responsibility; science teachers handle physiology, especially the physiology of health; and physical education teachers the personal hygiene side or the health education taught in the schools.

Overlapping is found not only in the matter of health instruction, but also between the home economics department and the science department. It frequently occurs also in the science that is given to vocational groups.

There is a growing conviction that science should be a constant in the program of studies throughout the three years of the junior high school. Glass found that of the fourteen school systems which he investigated, six included science as a core subject in the seventh grade, seven in the eighth grade, and three in the ninth grade. As an elective subject science was offered by two schools in the seventh grade, one in the eighth

7 Glass, J. M. Curriculum practices in the junior high school and in grades five and six. Supplementary Edu. Mono., p. 10.

grade, and eight in the ninth grade. This shows a general tendency to make science a core subject in the seventh and eighth grades and an elective in the ninth grade.

On this subject Glass says:

> Among the subjects that offer large social and practical values to a well-organized curriculum it would appear that science should receive particular recognition from curriculum makers. Such does not seem to be the case. However the attempt to bridge the gap in the junior high school between the nature study of the elementary school and the specialized science of the high school is clear evidence not only that the curriculum makers in some centers are aware of the important, if not indispensible, educational value of science in the seventh, eighth and ninth years, but that they are actually creating courses of study adaptable to the junior high school.
>
> Progressive organization of courses demands, first, that introductory courses be required in the seventh and eighth years, and second, that finishing courses be required in the ninth year. Units of instruction adapted to the maturity of the ninth year pupils should be included as the culminating contributions to the general and common training which it is the function of the core curriculum to supply.
>
> The steps in the introduction of natural science into the junior high school seem to be, first, an elective in the ninth year, second, an exploratory and introductory course for the eighth year, third, a still more elementary course in the seventh year, and the final step, which only three centers have taken, in the articulation of the required natural science of the seventh and eighth years and the nature study courses of the fifth and sixth years.
>
> The distinction of elementary science, nature study, general science, etc., is inherited from former practice of specialized science courses. The simple and all-inclusive designation of natural science for all years, at least of the elementary and junior high school, is adequate to define the subject of the curriculum. A contribution of incalculable value to the modern age of scientific life and achievement will be made by the junior high school if it succeeds in establishing science as one of the required constants of the program of studies in secondary education.[8]

These quotations from Glass' report bring out the fact that the science of the junior high school should be a progressive three-year course linking the nature study of the elementary grades with the specialized science of the senior high school. The exact topics that should be given in the first part of the

8 Glass, J. M. Op. cit., pp. 17, 50, 129.

junior high school course will be topics that connect the subject with the nature study of the grades. At the present time there is no well established practice regarding the teaching of nature study in the elementary grades. For that reason the course of study makers will need to ascertain just what the pupils have had and build up from that.

Another factor affecting the nature of the course is the variety of outcomes that are desired. Science can furnish the individual with a set of skills and knowledges that will be indispensible in his later life. With the idea of making the course serve that purpose certain things should be included in it. Again, one of the aims is to prepare for later specialized courses. This has made it necessary to put into the course material that would make it acceptable as a ninth grade elective to be used as a college entrance requirement. In order to make the subject a constant in the junior high school program, the college entrance requirements need to be changed from sixteen units of high school work to twelve units of senior high school work.

Lack of suitable text books has also kept many schools from including science. Were it possible to obtain teachers specially trained for the junior high school science, this would not be so large a factor, but at present few institutions are offering special training to teachers for this work, and without well developed courses of study and suitable text books it has seemed unwise to introduce the subject.

The exact content of the courses now being offered in various schools can be shown by an examination of several courses. The brief summaries given may be suggestive for the course of study makers.

(*To be continued*)

The Contribution of Slides and Films to Science Teaching*

By L. Paul Miller,
Central High School, Scranton, Pa.

The real value of slides and films in the teaching of science subjects depends on the care that is used by us, as teachers, in selecting and presenting them to our pupils. If these visual aids, with their tremendous possibilities, are dabbled in haphazardly, their educational value may be almost negligible. If, on the other hand, they are drawn upon with considerate forethought, their specific contribution to the educational process may be a veritable gold mine. The value of such visual aids, properly used, cannot be questioned. We need to supplement our textbooks by using real things and pictures of real things. In dealing with our pupils we must cease over-burdening the ear-drum and under-estimating the retina.

The primary end to be kept in view is not that of entertainment. Pictures are not sugar-coated doses of education. Their only legitimate use in our schools is to dramatize text-book topics, to make them more vivid, to provide lasting impressions.

Method of Use.

Still and motion pictures are used in four distinct ways: (1) in the classroom; (2) the school assembly; (3) the public assembly; (4) with selected groups of classes in the school auditorium. The use in the classroom is possible with a portable machine. It makes possible the use of pictures in direct connection with lesson assignments, and practically always gets undivided attention. The use in a school assembly, especially if it is a large school, has less chance of getting concentrated attention, and is hard to relate with class work. This use has, however, been made successfully in Scranton Central High School, in cases in which a program has been carefully arranged around a particular topic, as "Fire Prevention." Talks accompanied the pictures. One program was given by members of the senior class, on X-rays. Illustrated lectures were given, using slides and motion pictures. An audience of 1,500 seemed to enjoy this program, with evidence of close attention. Pic-

* Address delivered before the Pennsylvania State Education Association meeting at Scranton, Dec. 30, 1925. Reprinted by permission from "The Educational Screen."

tures have been used in the same way, accompanied by talks, at meetings of the Mothers' Club of the school, the talks having been given by the pupils, after full preparation. During American Education Week, this year, the auditorium was open to the general public throughout one school day, and motion pictures of general education interest were shown.

The last method has been found to be the most successful, that of taking groups of classes into the auditorium throughout the day. All science classes meeting at any given period are taken to the auditorium by their teachers, after roll check in the class rooms, and shown pictures of general use in science class work. Comments are given during the pictures. This is repeated during the seven periods of the school day. When a picture is scheduled to fit in especially with the Chemistry class work, only the Chemistry classes report. The same plan is followed for other subjects. Practically every week, usually on Fridays, the pupils in one or more subjects are shown pictures bearing on their subject matter. Each pupil gets this type of visual instruction on an average of once a month. There is no harmful interference with regular class routine, or scheduled work.

Text films or slides can be used in either the classroom presentation, or with class groups in the auditorium in larger schools. Films selected for such purposes would be in the nature of "The Amoeba" for Biology, or "Electrical Transmission of Speech" for Physics. Pictures of general educational value can be used in school assemblies or public assemblies. These must have some entertainment value, however, to hold attention, and cannot be specifically on classroom subject-matter. Their value is limited.

SOURCES OF PICTURES.

(1) Pictures may be bought by the school, (2) may be rented, (3) may be supplied and exhibited by a commercial concern, or (4) may be had for payment of expressage. Funds are not usually available for purchasing films, although slides can be made or purchased and kept on hand. It is hardly advisable to buy films when showings are infrequent, since disuse is sometimes as damaging to them as daily showing. Rental is possible when there are funds appropriated for the purpose, but there are available a number of "free" films. Showing,

under contract, by a commercial concern, frees the teacher of all responsibility. The scheduling of films at appropriate times, by teachers, from government bureaus and industries which require only the payment of expressage (usually less than a dollar for several reels each day) is satisfactory, but requires extra work. In Scranton, the Science department schedules films in this way. No funds are available this year, but express charges are paid from a student fund, raised by giving plays and concerts.

PROJECTORS.

If a contract is given by the school for the supplying and exhibiting of pictures, this phase of the question is no problem, since the company provides projectors. If slides are shown, an ordinary stereopticon, available in most schools, is all that is needed. The daylight projectors have undoubted advantages for classroom use. If they are not secured, dark blinds must of course be provided. If films are shown in the classroom, a portable machine and a licensed operator must be available. In auditorium projection the same provision for machine and operator must be met. New auditoriums should be equipped with projection booths, and machines installed. In this state a licensed operator is demanded for the showing of films under all circumstances. The only solution here, is for one or more of the teachers to serve the required apprenticeship, and secure the license. A pupil or laboratory assistant can be licensed if he is 18, but his tenure of office is necessarily brief. The state law here offers the greatest barrier to further progress in use of films.

TECHNIQUE.

Experience indicates that pictures are most useful when: (1) they immediately follow class assignments and discussion on their topic; (2) they are preceded by suggestive questions on their outstanding points; (3) they are followed the next day by short quizzes on these points; (4) they are accompanied by comments by a teacher while showing, or better, by an expert from outside; and (5) they are either preceded or followed, wherever, possible, by class trips to industries using related processes. No teacher should attempt to show pictures without first seeing them himself. The showing should be a class

exercise. There is no legitimate excuse whatever for showing pictures of any sort during school hours, except as part of school lessons. Outside speakers are always effective. Last Arbor Day, Dr. Illick, of the State Department of Forests and Waters, gave a splendid illustrated lecture to science classes in Scranton, and films on Forestry were shown. Mr. R. N. Davis, curator of the Everhart Museum in Scranton, has given several very illuminating illustrated lectures. Mr. Taylor, of the Scranton Water Company, has given illustrated lectures of the city's water supply system, at times when it was being studied by general science classes. Mr. Clepper, of the local office of the State Department of Forests and Waters, has lectured on trees. Class trips, taken in connection with motion pictures, have been made to the local telephone exchange, the Edison lamp works, the water company laboratory and filtering plant, and the printery of the International Corresponding Schools.

SUGGESTIONS.

In conclusion, the following suggestions are offered, based on Scranton's experience with the use of pictures, particularly films:

1. Every effort should be made to prepare for teachers, lists of all "free" films suitable for class use, classified under the various school subjects, and giving addresses where they may be secured. Such a list, still incomplete, is being made for use in Scranton. A comprehensive, printed list would be of value.

2. Films should be scheduled in advance by teachers, so that they may be correlated with classroom studies. They should have a preliminary run before being used.

3. Local school systems should be urged to allow for budgets to cover costs of such visual education. This is done in larger cities. The average cost for pictures, not including salaries of visual education directors, is given as $11,000 annually, in thirteen large cities. New York City's figure is $31,000. (Pictures are shown there by contract with a commercial exhibiting company.)

4. Teachers of the state should request larger state appropriations to the Philadelphia Museum and the State Museum, for use in distributing slides and films.

5. We should urge the production of non-inflammable films only, for educational purposes; of more pedagogical films that

can be better adapted to subject-matter; and of films of shorter length than the present 1,000-foot reels.

6. We should set a committee to work at once, to study present state laws and modifications thereof, governing the showing of non-inflammable films in schools, and to base thereon definite recommendations to be presented to the state legislature, urging reasonable modifications of the present laws in Pennsylvania, which would permit more general use of non-inflammable films for educational purposes. Newark, Atlanta, Detroit, San Francisco, and St. Louis schools have reported the securing of modifications of state regulations on portable machines, using non-inflammable films.

Lightning Rods a Real Protection

Lightning rods, with their accompanying air terminals and ground connections, when properly installed as a system on a building or other structure, give nearly complete protection from lightning.

Statistics from such a state as Iowa, where thunderstorms are frequent, show that more than 95 out of each 100 buildings sustaining fire losses from lightning, were not rodded. It is estimated that about 50 per cent of the farm buildings in Iowa are rodded.

Lightning rods, or more properly lightning conductors, are nearly always made of copper or heavily galvanized iron or steel, the former generally in the form of a stranded cable, the latter of star cross-section twisted into a long spiral. Copper is somewhat the better in durability. Both kinds of conductor, when correctly installed, give satisfactory protection. Copper conductors should weigh not less than 3 ounces per foot; iron not less than 320 pounds per thousand feet, or a little over 5 ounces per foot, says the Weather Bureau of the United States Department of Agriculture.

Lightning conductors should be attached direct to the surface of a building without insulators. The air terminals to protect upward-pointing parts of the roof should be secured against overturning by the wind, and the ground connections extended downward to permanently moist soil, usually found at a depth of 8 or 10 feet below the surface. All joints should be permanently made and of low electrical resistance.—*U. S. Department of Agriculture.*

The Pronunciation and Spelling of Words Used in Science

By Duane Roller,

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Teaching the Pronunciation of Scientific Terms.

If the science student is taught the proper pronunciation of scientific terms when he first encounters them, he will be spared the difficulty of relearning the pronunciation later, and will also be taking an important step toward the enlargement of his scientific vocabulary. The student will often avoid technical words in his oral recitations because he is uncertain of their pronunciation, and he will refer to an apparatus or process as a "what-do-you-call-it," even when not entirely ignorant of its proper name.

New words are most easily learned when they are first experienced, for "the path from ignorance to knowledge is easier and less complicated than that from error to knowledge."[1] There are, however, many semi-technical words, such as *laboratory, data, propagation, vacuum, horizon* and *acclimate,* which are common to ordinary language and to scientific terminology, and the student may learn to pronounce them improperly before coming to the science class. The correction of these old habits is a very difficult and tedious process. Whether the science teacher shall take the time for such corrections is a problem in correlation which cannot be settled here. On the other hand, teaching the pronunciation of new words encountered in science study is not a matter of correlation. Being one of the means of realizing commonly accepted objectives in science teaching, it is a valuable class-room activity which does not depend upon the validity of the much disputed doctrine of correlation for its justification.

How to Teach Pronunciation.

Pronunciation is best learned by imitation. Many general science teachers know from their own experience in learning to pronounce technical terms, that this is at least the easiest method; for they, more than others, must occasionally use technical words without ever having heard them pronounced.

1 Henry Suzallo, "The Teaching of Spelling," p. 105, Houghton Mifflin.

To say, however, that oral example and imitation is the best method does not imply that students should not be taught to interpret such devices as diacritics, syllibications and accents, and encouraged to develop sensitivity for discrepancies in pronunciation. The formation of such habits is important, for they are the basis of self-cultivation. The chief concern of the science teacher, however, is to give his students immediate power over the pronunciation of scientific words, and for this purpose the method of oral example and imitation has no superior.

Standards of Pronunciation.

Our language often shows considerable diversity of usage in the pronunciation of the same word. Moreover, usage is incessantly changing, and one must learn to tolerate and expect differences of pronunciation. "Language exists only in the individual, and such a phrase as 'standard English pronunciation' expresses only an abstraction."[2] Brander Matthews believes, nevertheless, that there is a normal pronunciation which we all, more or less, recognize, and to which we seek to conform. To quote from his essay on *A Standard of Spoken English*:[3] "True it is that there is nowhere to be found an inexpugnable authority having power to declare absolutely a final standard of pronunciation, and true it is also that there are many divergencies of utterance, national, sectional, local, and individual, yet this diversity is far less than might be supposed. A large part of it is unconscious and would be denied indignantly by a majority of those who are guilty of it. Men whose pronunciation may be slovenly to the very verge of illiteracy are often unaware of their linguistic delinquencies; and many of them would be greatly shocked if they could hear with their own ears an exact reproduction of their habitual utterances. The majority of us recognize that there is a normal pronunciation and we fondly believe that we conform to it." Professor Utter sums up very nicely the matter of standards of pronunciation in the statement: "In pronunciation, whatever is, is right, only in the sense that every man may pronounce as he pleases if he is willing to take the consequences."[4]

2 Henry Sweet, "Primer of Phonetics," 3d ed., rev., p. 3, Oxford Press.
3 Brander Matthews, "Essays on English," p. 210, Scribner's.
4 Robert Palfrey Utter, "Every-Day Pronunciation," p. 2, Harper.

Proper Names.

Foreign proper names are, of course, predominant in the history of natural science, and many of them are found even in elementary textbooks. Since the proper pronunciation of these names is a matter of considerable importance to the teacher, it may prove of value to quote from the Preface to Lippincott's Pronouncing Biographical Dictionary, where Joseph Thomas gives an able discussion of this subject.

"In pronouncing proper names there are only three courses which can by any possibility be pursued: first, to blunder over or pronounce them at random, like a barbarian who should attempt to speak a language of which he knows nothing; secondly, to endeavor to pronounce all names, foreign as well as English, according to the principles of our own language, giving each letter its proper English sound; or lastly, . . . to pronounce all names, as nearly as possible, as they are pronounced by the well-educated people of the different countries to which such names belong, with the exception of those very few celebrated names, such as Galileo . . . which may be said to have acquired an established English pronunciation."

* * * * *

"The only rational course . . . is to adopt the third method noticed above, and to pronounce modern names, as nearly as possible, as they are pronounced by the inhabitants of the respective countries to which such names belong. . . . Nor are the obstacles in the way of acquiring such a pronunciation nearly so great, even for the ordinary English scholar, as at first sight might appear."

* * * * *

"The acquisition of ten or twelve new sounds, which might be learned by persons of ordinary aptitude in a few hours, would enable anyone who can read correctly the pronunciation of English words . . . to pronounce with tolerable correctness all the names of Portugal, Spain, Italy, France, Belgium, Holland, Germany, Denmark, (and) Norway. . . ."

Dr. Thomas points out that Russian and Oriental names must be spelled according to the sound, since originally they are neither written in Roman letters nor in characters which can be converted into corresponding Roman letters. Oriental names, he says, are difficult to pronounce because there is in

our language no uniform system for writing such names; moreover, the character of Oriental language is so different from that of languages with which we are familiar that it is often difficult to indicate the pronunciation in a satisfactory manner.

Common Mistakes in Pronunciation.

Some words are commonly mispronounced by omitting certain sounds. Rapid speech and carelessness result in habits of contracting such words as *laboratory, machinery, mercury, arctic* and *vacuum*. Other words are mispronounced by incorrectly adding certain sounds, as in *buoy, circuit* and *conduit*. Another common type of error is misplaced accent, and for this case the dictionary is the only safe guide. A tendency on the part of English-speaking people to carry the accent back toward the first syllable is recognized by orthoepists. The struggle between past usage and this tendency toward recession in accent is reflected in the present confusion regarding the disposition of the accent in *illustrate* and *demonstrate*.

In the following list of words often mispronounced, there has been no attempt to give an exhaustive description of the pronunciations, but only to point out common errors. In the case of a few words, pronunciations differing from those indicated are admitted by some authorities; most of these words are marked with an asterisk. Asterisks which do not precede words, but which are placed in the description of its pronunciation, refer only to that part of the description contained in parentheses.

A List of Words Used in Science which are Often Mispronounced.

*ab-do′men	Accent on second syllable.
ab-sorp′tion	Second syllable *-sorp′*, not *"-sorb"*.
ac-cli′mate	*a-kli′mat*, first *a* as in *add*. Accent on second syllable. (Second *a* as in *senate*).*
ac′cu-rate	Three syllables, not *"ak′ret"*.
ad″i-a-bat′ic	First *a* as in *add*, each *i* as in *ill*, second *a* as in *ask*.
a′er-ate	Each *a* as in *fate*. Not *"air′e-ate"*.
a′er-i-form	Four syllables. First *a* as in *fate*.

a-e′ri-al	Four syllables. First *a* as in *fate*, *e* as in *sea*.
a″er-o′bi-a	Five syllables. First *a* as in *fate*, *o* as in *go*.
a′er-o-plane	Four syllables; not *"air-o-plane"*. First *a* as in *fate*.
*an′i-lin	Last *i* as in *ill*.
ant-arc′tic	Pronounce as spelled. See *arctic*.
an-tip′o-des	Four syllables, with accent on second. The singular form is *an′ti-pode*.
*ap″pa-ra′tus	Last *a* as in *fate*.
a′qua	First *a* as in *fate*.
a′que-ous	*a′kwe-us*, *a* as in *fate*, *e* as in *society*.
arc′tic	*ark′tik*, not *"ar′tik"*.
a′re-a	First *a* as in *fate*.
as-bes′tos	First *s* as in *this*.
Au-ri′ga	*i* as in *ice*, *g* as in *go*.
au-ro′ra	*au* like *a* in *what*, *ro* as in *rose*.
au-ro′ra bo″re-a′lis	*borealis* is pronounced with *o* as in *go*, *e* as in *society*, *a* as in *fate*.
aux-il′ia-ry	*aug-zil′ya-ri*, not *"auks-"*.
ba′ri-um	*a* as in *fate*.
bo′ron	First *o* as in *old*. Not *"bor-"*.
Bra′he	*bra′e*. *a* as in *father*, *e* as in *eyd*.
*buoy	*boi*, *oi* as in *oil*.
buoy′ant	Last syllable *-ant*, not *"-yant"*.
bu-rette	*u* as in *unite*. Not *"bur-"*.
caf′fe-in	Three syllables. (*i* as in *tin*.)*
car′bu-ret″er	*e* as in *set*.
Cas″si-o-pe′ia	Primary accent on fourth syllable.
cel′lo	*chel′o*, not *"sel′o"*.
cen-trif′u-gal	*u* as in *unite*, *a* as in *final*.
cer′e-bral	Accent on first syllable.
cer′e-brum	Accent on first syllable.
chal-ced′o-ny	*kal-sed′o-ny*, *a* as in *add*, *e* as in *get*.
Chlad′ni	*klad′ne*, *a* as in *father*.
chlo-rid	*o* as in *go*. Not *"chlor-"*. (*i* as in *ill*).*
chlo′rin	*o* as in *go*. Not *"chlor-"*. (*i* as in *ill*).*
chlo′ro-form	First *o* as in *go*. Not *"chlor-"*.
chlo′ro-phyl	First *o* as in *go*. Not *"chlor-"*.
cir′cuit	*sir′kit*.

com-mu'ta-tive	Accent on second syllable.
com'pass	*o* as in *son*.
com-po'nent	Accent on second syllable.
con'duit	*ui* like *i* in *admit*.
Cu"rie'	*u* as in *Dumas* (French), *ie* like *i* in *sea*.
da-guerre'o-type	*a* as in *ask*, *o* as in *obey*. Accent on second syllable, which is *ger'*, *ge* as in *get*.
da'ta	First *a* as in *fate*.
*dem'on-strate	Accent on first syllable.
Dew'ar	*du'ar*, *u* as in *use*, *a* as in *senate*.
di-ox'id	Last *i* as in *habit*.
diph-the'ri-a	*dif-the'ri-a*, *e* as in *sea*.
e"qua-to'ri-al	*e* as in *sea*, *o* as in *go*.
e"qui-li'brate	First *e* as in *sea*, second *i* as in *ice*.
Eu-sta'chi-an	*yu-sta'ki-an*, *a* as in *fate*.
ex-per'i-ment	Second *e* as in *end*.
ex-po'nent	Accent on second syllable.
flu"o-res'cence	First *u* as in *true*. Four syllables.
Fraun'ho-fer	*frown-ho'fer*, *second o* as in *go*.
Freud	*froit*, *oi* as in *oil*.
Freud'i-an	*froid'i-an*.
fun'gi	*fun'ji*, *i* as in *ice*.
gi'la	*he'la*, *e* as in *sea*.
Green'wich	*grin'idz*, *z* as in *azure*.
gy'ro-	*g* as in *gin*, *y* as in *type*.
go"ni-om'e-ter	First syllable like word *go*. Not "*gon-*".
ho-ri'zon	Accent on second syllable.
hun'dred	Last syllable *-dred*, not "*-derd*".
hy'brid	*i* as in *habit*.
*hy-drox'id	*i* as in *bid*.
*hy'gi-ene	Three syllables. The *gi* as in *gin*.
hys-te'ri-a	*e* as in *sea*.
im-pe'dance	Accent on second syllable. First *e* as in *sea*.
in-cline'	First syllable *in-*, not *en-*. (Accent on last syllable.)*
in'te-gral	Accent on first syllable.
in'ter-stice	*in'ter-stis*, final *is* as in *this*.
in"ter-sti'tial	*in"ter-stish'al*, second *i* as in *hit*.
*i'o-din	Last *is* as in *ill*.
i-soch'ro-nal	*i-sok'ro-nal*.

ī″so-ther′mal	*i* as in *pine.*
Joule	*joul. ou* as in *out.*
ju′gu-lar	First *u* as in *true.* Not *"jug-".*
kil′o-me″ter	Not *"ki-lom′eter".*
ki-net′ic	Accent on second syllable. First *i* as in *ill.*
kiln	*n* silent.
lab′o-ra-to″ry	Five syllables; not *"lab-ra".* Last *o* as in *go.*
La″place′	Each *a* as in *father.*
lar′ynx	*lar′inks, a* as in *add.* Not *"lar-nix".*
li′chen	*li′ken, i* as in *pine.*
Lie′big	*le′bik, e* as in *sea, i* as in *bid.*
li′ter	*i* as in *police.*
ma-chin′er-y	Four syllables; not *"ma-chin-ry".*
me-nis′cus	*e* as in *society.* Not *"men-".*
mer′cu-ry	*u* as in *futility.* Three syllables, not *"merk-ry".*
min″er-al′o-gy	Third syllable *al,* not *"ol".*
mon′grel	*o* as in *son.*
mon-ox′id	First *o* as in *odd, i* as in *habit.*
ni-trog′e-nous	*ni-troj′e-nus,* first *o* as in *odd.*
No-bel′	Accent on second syllable. *o* as in *obey.*
nu-cle′o-lus	Accent on second syllable.
*ob-lique′	*i* as in *police.*
Oer′sted	*oe* like *u* in *urn, d* like *th* in *bathe.*
o″le-o-mar′ga-rin	*g* as in *go,* second *a* as in *sofa.* Not *"-jerin."* (Last *i* as in *tin.*)*
Ost′wald	*ost′valt, o* as in *go, a* as in *father.*
par′af-fin	*par′a-fin, i* as in *tin.*
pe-num′bra	*e* as in *valley,* Not *"pen-".*
Pe-tit′	*pe-ti′, e* as in *rider, i* as in *police.*
Pi′sa	*i* as in *police.*
Po-la′ris	*o* as in *obey, a* as in *fate, i* as in *ill.*
pos-te′ri-or	First *o as* in *not, e* as in *sea,* last *o* as in *rumor.*
prop″a-ga′tion	First *o* as in *not.* Not *"pro-".*
pro′te-in	Three syllables. Not *"pro-teen".*
*prus′sic	*prus′ik, u* as in *up.*
quad′ru-ple	Second *u* as in *full.*
quan′ti-ty	Second syllable *ti,* not *"i".*

re-a'gent	Accent on second syllable. *a* as in *fate.*
Re"au"mur'	*ray"-o"meer'.*
re"ge-la'tion	*re"je-lay'shon,* first *e* as in *sea.* Not *"reg-".*
Re-gnault'	*re-nyo',* *e* as in *over,* *o* as in *go.*
Reg'u-lus	*eg* as in *leg.*
*rep'tile	*i* as in *habit.*
re-search'	Accent on last syllable.
re-tort'	Accent on last syllable.
Roe'mer or Rö'mer	*oe* nearly like, and last *e* like, the *e* in *her.*
Roent'gen, Rönt'gen	*runt'gen,* *u* as in *urn,* *g* as in *go.*
ru"di-men'ta-ry	*u* as in *rule.*
sca-lene'	*a* as in *fate.* Accent on second syllable.
se-le'ni-um	Second *e* as in *sea.*
se'nile	First *e* as in *sea.* (*i* as in *pine*).*
si-de're-al	*i* as in *ice,* first *e* as in *sea.*
si"mul-ta'ne-ous	*i* as in *ice.*
slake	*a* as in *fate.*
*sol'der	*sod'er.*
*so'le-noid	*o* as in *go.*
so-lute'	*o* as in *obey.* Accent on last syllable.
spher'i-cal	First syllable *sfer',* *e* as in *end.*
sphe'roid	*e* as in *sea.*
ster'ile	First *e* as in *end.*
stom'ach	*a* as in *about;* not *"stom'ick".*
stra'ta	First *a* as in *fate.*
stra'tum	First *a* as in *fate.*
strych'nin	Last syllable either *nin* or *neen,* but not *nine.*
sul-fu're-ous	First *u* as in *pupil.*
tan-gen'tial	Three syllables, *tan-jen'shal.*
tem'per-a-ture	Four syllables; not *"tem'per-ture".*
tep'id	*e* as in *set.* Not *"te'pid".*
thou'sand	Last syllable *-zand,* not *"-zan".*
tim'bre	*tim'ber.*
Tor"ri-cel'li	Third syllable *chel'.*
tour'ma-lin	First syllable like word *tour.* (*i* as in *tin*).*
tour'ni-quet	First syllable *tour',* last syllable *-ket.*
*tox'in	*i* as in *habit.*
tu'mor	*u* as in *pupil,* *o* like *e* in *maker.*
*tur'bine	*i* as in *tin.*

tube	*u* as in *pupil;* not *"toob".*
tune	*u* as in *pupil;* not *"toon".*
tym'pa-num	Accent on first syllable.
un'du-la-to-ry	Accent on first syllable.
U'ra-nus	Accent on first syllable.
vac'u-um	Three syllables; not *"vac-yum".*
va-ri'o-la	Accent on second syllable. *i* as in *ice.*
Ve'ga	*e* as in *sea, g* as in *go.*
vi'al	Two syllables; not *"vile".*
Vin'ci	*ven'che,* each *e* as in *sea.*
vir'u-lent	*u* as in *full;* not *"-yu-lent".*
vis'cer-a	*vis'er-a.*
vis'cid	*vis'id.*
vit'ri-ol	Three syllables; not *"vit'rul".*
wa'ter	*a* as in *all;* not *"wot'er".*
*xy'lo-phone	*y* as in *type.*
yel'low	*e* as in *obey,* and not like *u* in *hut.*
yt'tri-um	*y* as in *physics.*
ze'ro	*e* as in *sea;* not *"zir'o."*
zinc'ic	*zink'ik.*
zo-di'a-cal	Accent on second syllable.
zo-ol'o-gy	First *o* as in *obey.* Not *"zoo-".*

SIMPLIFIED SPELLING OF WORDS USED IN SCIENCE.

There is ample justification for using and teaching the simpler spelling contained in the following list. All of these spellings are given first preference in the Standard Dictionary.*

New Form	*Old Form*	*New Form*	*Old Form*
analog	analogue	dioxid	dioxide
anemia	anaemia	distil	distill
anesthetic	anaesthetic	esophagus	oesophagus
anilid	anilide	ether	aether
anilin	aniline	fiber	fibre
antitoxin	antitoxine	flourin	flourine
bromid	bromide	gage	gauge
bromin	bromine	gelatin	gelatine
caffein	caffeine	glycerin	glycerine
caliber	calibre	goiter	goitre

* See also Simplified Spelling Board Circular No. 2, 1906, reprint, Government Printing Office, Washington.

New Form	*Old Form*	*New Form*	*Old Form*
caliper	calliper	hemoglobin	haemoglobin
calory	calorie (Fr.)	hydroxid	hydroxide
chlorid	chloride	iodid	iodide
chlorin	chlorine	iodin	iodine
chlorophyl	chlorophyll	lacrimal	lachrymal
meter	metre	saltpeter	saltpetre
miter	mitre	sulfate	sulphate
monoxid	monoxide	sulfid	sulphid, sulphide
neutralize	neutralise		
niter	nitre	sulfite	sulphite
oleomargarin	oleomargarin	sulfo-	sulpho-
oxid	oxide	sulfur	sulphur
paraffin	paraffine	sulfuric	sulphuric
saccharin	saccharine	toxin	toxine

The following simpler spelling of words used frequently in natural science have been selected from the list recommended by the Philological Society of London and the American Philological Association.[5] These spellings have not as yet received general acceptance and they are given here merely as an illustration of the changes in spellings which can be expected in the future. Teachers who are interested in the simplified spelling movement should procure the bulletin, "Some Simpler Spellings," compiled by Dr. J. W. Scroggs, of the University of Oklahoma.[6]

Present Spelling	*Suggested Spelling*	*Present Spelling*	*Suggested Spelling*
accelerative	accelerativ	amphibia	amfibia
alpha	alfa	angle	angl
amorphous	amorfous	annealed	anneald
asphalt	asfalt	geography	geografy
asphyxia	asfyxia	gill	gil
atmosphere	atmosfere	granite	granit
atrophy	atrofy	hydrophobia	hydrofobia
auricle	auricl	intestine	intestin

5 See "Webster's Universal Dictionary, Appendix, p. 268, Bufton, Kansas City, 1916.

6 "Some Simpler Spellings," Univ. of Okla. Bul., Oct. 1, 1921. This bulletin may be secured free from the Extension Division, Norman, Okla.

Present Spelling	*Suggested Spelling*	*Present Spelling*	*Suggested Spelling*
axle	axl	island	iland
circle	circl	lead	led (metal)
cohesive	cohesiv	malleable	malleabl
color	culor	measure	mezure
condensed	condenst	metamorphosis	metamorfosis
conduit	condit	negative	negativ
contractile	contractil	nerve	nerv
eclipse	eclips	nozzle	nozl
ellipse	ellips	ophthalmic	ofthalmic
engine	engin	permeable	permeabl
erosive	erosiv	pharmacy	farmacy
eye	ey	pharynx	farynx
focused	focust	phase	fase
freeze	freez	phonograph	fonograph
fuse	fuze	phosphate	fosfate
fusion	fuzion	phosphorus	fosforus
gauze	gauz	photography	fotography
photometer	fotometer	soluble	solubl
physical	fysical	solve	solv
physicist	fysicist	sphere	sfere
physics	fysics	spheroid	sferoid
physiology	fysiology	sponge	spunge
plumb-line	plum-line	stomach	stumac
positive	positiv	telegraph	telegraf
prehensile	prehensil	telephone	telefone
reflexive	reflexiv	ton	tun
reproductive	reproductiv	tongue	tung
revolve	revolv	valve	valv
sessile	sessil	ventricle	ventricl
siphon	sifon	worm	wurm

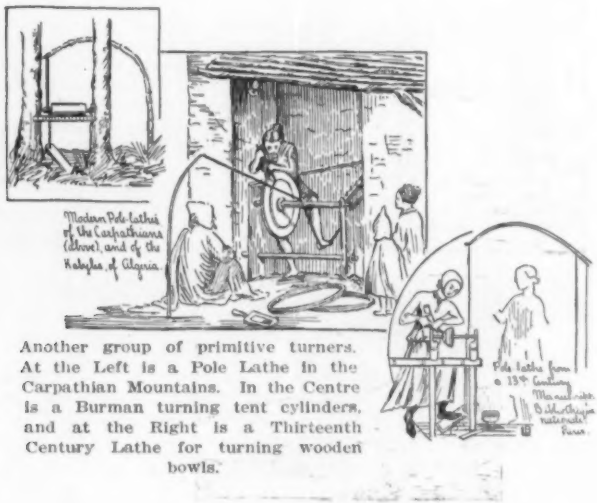
Modern Lathes *

By Edwin Seaver.

Illustrations by Edna Hood Lissak.

Editor's Note.—This is a sequel to the article "Turnynge," which was printed in the May, 1926, issue of the General Science Quarterly.

It is a far cry from the simple lathe on which King Louis XIII of France turned out his ivories and vases, to the modern electrically driven, heavy tire-turning lathe used in railroad shop work. Yet the principle of the lathe remains unchanged through all these centuries. The one great difference between the lathes with which the nobility of the Ancient Regime used to occupy themselves and the lathes used today



Another group of primitive turners. At the Left is a Pole Lathe in the Carpathian Mountains. In the Centre is a Burman turning tent cylinders, and at the Right is a Thirteenth Century Lathe for turning wooden bowls.

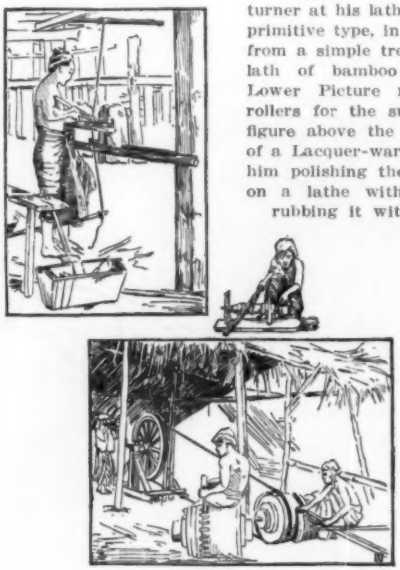
by American workmen, is the element of power drive, the vital element of electricity making it possible to meet the enormous demands of modern industry.

The problem of how to obtain increased production is the motive back of all development in machine tools. Human labor is insufficient for the great needs of our day. Yet more

* From "The Edison Monthly," by courtesy of the New York Edison Co.

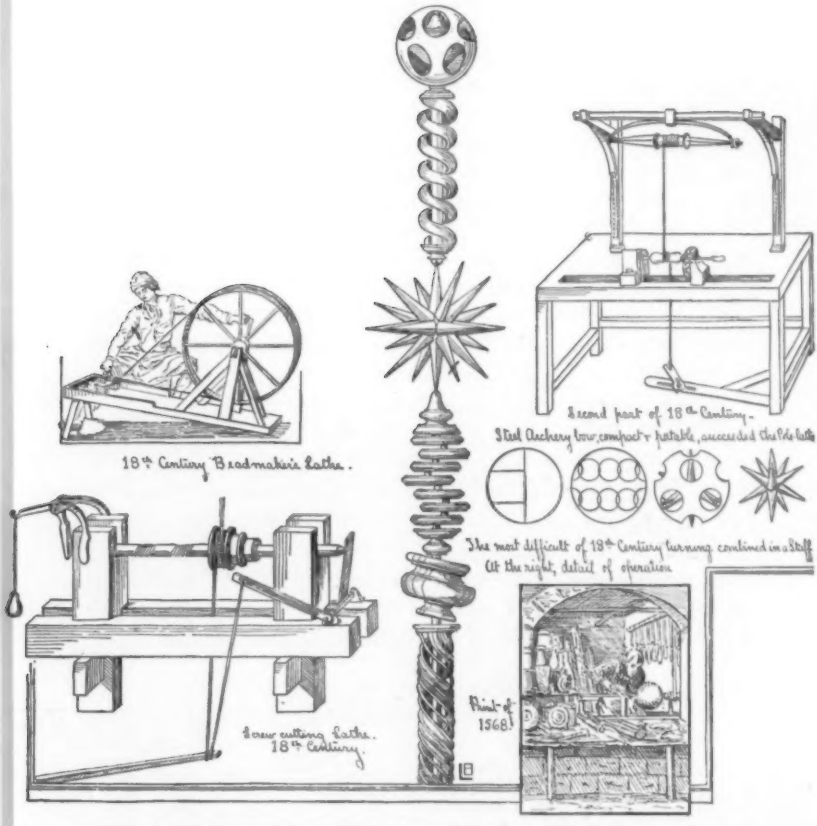
and more work has to be produced. The solution lies in increasing the efficiency of our machines and thereby making them capable of producing a larger output of work.

Rigidity and power are two vital factors in obtaining large production. A rigidly supported tool will outproduce and last longer than a tool that "chatters." The work must be held rigid and have abundance of power behind it to make possible the rapid removal of metal in large castings or forgings of high tensile strength.



The Upper Picture shows a Burman turner at his lathe. It is of the usual primitive type, in which a cord passes from a simple treadle-bar to a spring lath of bamboo overhead. In the Lower Picture natives are turning rollers for the sugar-cane mill. The figure above the lower illustration is of a Lacquer-ware Turner, and shows him polishing the sides of an article on a lathe with pumice stone and rubbing it with black wood oil.

These two problems: rigidity and power—getting the greatest convenience of manipulation combined with abundance of power—lie back of all the developments of the great lathes used in industry today. Mechanical engineers are constantly improving their old models, with increased speed and accuracy obtainable through greater rigidity as their goals. And the problem of power is being solved through an increasing concentration on the unit drive for all lathes.


18th Century Broad-maker's Lathe.
Second part of 18th Century.
Steel Archery bow; compact & portable, succeeded the Pole Lathe
The most difficult of 18th Century turning, contained in a Staff
At the right, detail of operation
Print of 1568
Screw cutting Lathe.
18th Century

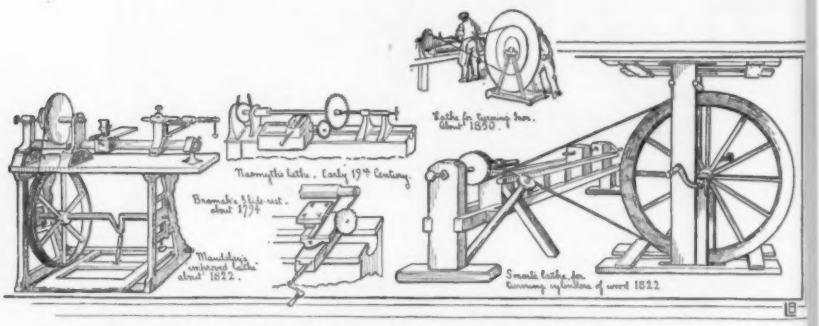
A Group of Eighteenth Century Lathes, and one of the Sixteenth Century, with an intricate example of the turners' art.

Most lathes are arranged for either an overhead shaft or a unit drive motor. The advantages of the latter type of power, however, so easily outweigh the former type, that the tendency toward using individual motors for each lathe meets practically no opposition. Besides the fact that the overhead drive is an obstacle to good lighting and that it is responsible for accidents that cannot occur when the unit drive is used, the electric motor allows for a wide variation of speeds, some lathes using as many as eight different speeds.

Motor-drive lathes are used for both metal and wood work. There are more than three hundred different kinds in use, but for general purposes they may be divided into Geared Head, Heavy, and Precision Lathes. The Geared Head type may in turn be subdivided into General Purpose lathes and Special lathes, made to do only one definite kind of job. The General Purpose lathes range from 12-inch to 30-inch sizes, performing general work, such as casting bar stock, within capacity.

An interesting type of Special Purpose lathe is the turret variety, so called because of a turret-like device to hold the tools, providing opportunity for several cutting tools to be brought progressively into action, and at the same time strengthening their rigidity, thus increasing the amount of metal which it is possible to remove per minute.

Heavy lathes are also manufactured either for general work in railroad shops, or for turning out special coach and driving wheels. One of the big specimens of this type of lathe is the 90-inch driving wheel lathe with 40-horsepower motor and six tire turning speeds. This lathe is intended for average railroad shop work. It swings 90 inches maximum, and will turn wheels 88 inches in diameter maximum over the tread to 45 inches minimum. The main driving motor is situated on the heavy bed. The weight of this lathe is 90,000 pounds.


Lathe for turning bore. about 1850.
Nasmyth's lathe. Early 19th Century
Bramah's slide rest. about 1797
Maudslay's improved lathe. about 1822.
Smeaton's lathe for turning cylinders of wood 1822.

Lathes of the Nineteenth Century, showing the improvement of power application and the refinement of design.

We do not generally think of the wheels of railroad trains being supplied with tires. Yet they are, and the bumpy feeling that one sometimes has when riding in a coach is caused by a flat tire. It is this lathe that re-tires train wheels. The

process is known as "freezing" the tire to the wheel, this being done by putting on the tire when it is hot, and then allowing it to cool. The result is a tire so tight-fitting it cannot readily be distinguished from the main body of the wheel.

One of the largest lathes in use today is a combined lathe and grinder for machining the rotors of large size turbo-alternators. This lathe has a 113-inch swing over the bed and 44-inch over the carriages. It will accommodate work up to 45 feet between centers, and is capable of supporting a working load of 300,000 pounds. This giant machine is equipped with eight motors, five of which are controlled magnetically from push-button stations. The remaining three are controlled from drum switches. All of this equipment is mounted on the machine except the main drive motor panel, which is floor mounted.

The Double Spindle Semi-Automatic Bushing Turning Lathe is a special purpose lathe adapted for duplicate operation. It is a high production machine for turning brass, bronze, aluminum, and such materials requiring high spindle speeds. Its special countershaft construction is also ideally suited to many turning jobs for which a lower speed is advisable. An important feature of this machine is that it opens and closes the spring chuck automatically, thus permitting work to be put on and removed without stopping the spindles. The drive on this lathe is transmitted from a double pulley-type motor, belted to a pulley on each of the two lathe spindles. The left spindle is belted to the gear-box below and from this gear-box to the drum, loose change gears are employed to give a wide range of feeds. For machining parts requiring a slower turning speed than is practical for brass, bronze and similar materials, a single end motor and a special countershaft with ball-bearing construction is included, to reduce the speed from motor to spindles.

Every sort of turning to be found in wood-work today can be produced in large quantities on the modern wood-turning lathes. One machine alone, with automatic feeding attachment, can turn out table legs and pedestals, piano pillars, piano stool legs, standards and posts for bureaus, chiffoniers, table and toilet stands, bed-posts and reaches, chair legs, ten-pins, Indian clubs, dumb-bells, neck yokes, ball bats, lawn-mower handles, hammer handles, pump handles, or indeed any style

of turning within the machine's capacity. Nor is the grace and delicacy of antique furniture necessarily lost in modern machine production, for mechanical lathes have been perfected to such a degree that they approach the old hand lathes in their sensitiveness to the operator's manipulation.

Not only do our modern lathes out-distance the old style machines in production capacity, in size and speed, they are also capable of far greater precision and accuracy. Thus the Precision Lathe can be adjusted to the thousandth of an inch, and has a rigidity that is almost 100 per cent efficient. It is used for such delicate work as turning the wheels of a watch. The lead screw in this lathe is so accurate it does not vary in lead more than two ten-thousandths of an inch per foot.

The Earmarks of a Good Science Teacher*

By ELLIOT R. DOWNING.
School of Education, University of Chicago.

1. The Science teacher should have a clearcut notion of what he expects to accomplish with his pupils by the use of science materials. To this end—

(a) He should know and have definitely outlined in his own mind the knowledge he asks his pupils to acquire. He should be convinced that this knowledge is of large social value to his pupils.

(b) He must himself possess the scientific attitude of mind; he must be cognizant of the steps in the process of scientific thinking, so that he may effectively guide his pupils in their acquisition of the scientific attitude of mind. He must enthusiastically believe in the scientific attitude of mind as the great contribution of science to man's welfare.

(c) He should be so saturated with the biographies of some great scientists and the histories of some great scientific discoveries that he can impart his enthusiasm to his students and lead them to appreciate what science has cost and how it has been achieved.

2. Not only must he have thus definitely before him the ends he seeks to accomplish, but he must be skillful in plan-

* A paper presented at the Ohio State Educational Conference, Columbus, Ohio, April 9th, 1926.

ning each lesson so that each exercise will have definite objective and work into the plan of the whole just as each cog or belt fits into its place in the whole machine.

3. (a) He must himself know how to study and how to direct immature minds to acquire proper habits of study in science. He will need to know the probable difficulties of the students and be quick to diagnose and remedy them.

(b) He must know, therefore, how the thinking of young people differs from that of adults; what mistakes they are likely to make and how they can be led to avoid and overcome such difficulties.

4. He must acquaint himself with the interests and point of view of his pupils. Problems that seem worth while to him may appear dull and stupid to them. He is fitting pupils to cope with their own immediate problems, not with his.

5. He must be a seer, potent to reveal the marvels of the commonplace, the mysteries of the familiar, the strange histories that are unknown to the uninitiated. He must possess something of the sensitiveness of the artist and the impressionability of the poet, so that the sublime beauty and infinite power of nature may play upon him to engender that contagious enthusiasm, that fire of faith that kindles an appreciation of Nature's moral significance.

6. He must try to keep reasonably up to date in his specialty and in the pedagogical problems connected with his teaching. It would seem wise for him to be a member of some scientific society, and regularly read at least one journal dealing with science and its teaching.

The teacher of science should be all of this and more, for nothing has been said of his character and personal qualifications. They will be common to the genus teacher. Here interest centers in the specific characters of the science teacher. Some of the things that have been noted must be part of his heritage, must be born in him; others he may get from courses of study. He should have a broad foundation in the sciences; courses in astronomy, geology, physics, chemistry, and biology, particularly ecology. He must have a course on the selection and organization of materials, methods and testing results in science teaching. A course, or at least wide reading, in the history of science would be desirable. Of course, he must be

grounded in general methods, the psychology of learning and the psychology of the child.

It is manifest from such an enumeration that the science teacher is constantly preparing for his job. After the initial graduation from college come postgraduate work, summer schools, incessant reading of new books, of current magazines, meetings of scientific and educational associations.

It seemed advisable, in preparation for this paper, to check up on the somewhat idealized statement given above, and find out what conditions actually maintain among successful science teachers. One criterion of the good teacher enumerated above, is that he is a member of some association of his progressive fellows and that he reads some journal devoted to science and science pedagogy. This condition is met by members of the Central Association of Science and Mathematics Teachers. So three hundred letters with enclosed blanks for information were addressed to these members who it was judged were teaching the natural sciences in high schools. A self-addressed and stamped envelope for reply was of course included in the letter. One hundred and four replies have been received that can be included in the report.

The questionnaire calls for information regarding the science subjects being taught by each teacher, the preparation of the teacher for science teaching, and his familiarity with some standard and some very recent books on the technique of science teaching, and on the history and biography of science. It was impossible to secure information on all the earmarks of the good science teacher stated above without making the questionnaire tediously long. It was possible to secure it for a representative few.

12 of these teachers teach General Science alone.

16 of these teachers teach biology, botany, or zoology alone.

23 teach two or more of these subjects or one or more of them in connection with other non-biological sciences.

16 teach physics only.

13 teach chemistry only.

13 teach chemistry and physics.

11 teach one or both chemistry and physics together with General Science.

The preparation of these teachers is surprisingly good. Only five out of the lot had no science in high school, the average

is nearly three years (2.78 years) of such science, though less than one year's work (.65 year) is on the average taken in high school in that particular subject in which they are now doing the major part of their teaching. There is only one out of the lot who is not a college graduate, he is a normal school graduate. Thirty-four held master's degrees, two doctor's degrees. The average number of years of science taken in undergraduate college work is 6.55, 3.16 years of which is in the science now their major teaching interest. Every one took at least one year of college work in the science that is now his chief teaching subject. Seventy-one have done postgraduate work in science, ranging from a six weeks summer course to 7⅓ years of science, the average being 2⅓ years. of which 1.72 years is in the science subject now the major teaching interest.

On an average these science teachers have had courses either in high school, college, or postgraduate work in four (3.66) other subjects besides the one now their chief subject of instruction. Only one person has not had courses in any science other than the one he is teaching, and the maximum number of other sciences in which courses have been taken is seven, grouping all biological subjects together as one subject.

Contrast this with the conditions disclosed in a survey of 1,700 teachers of Kansas high schools, Bulletin, University of Kansas, Vol. xv, No. 16, July, 1915. Of the teachers of botany, only 49% had had any botany courses in addition to their high school courses; 35.7% of the zoology teachers, 75% of the physiology teachers, 64% of the general science teachers, 86% of the physical geography teachers, 34.2% of the chemistry teachers, and 41.4% of the physics teachers were without any preparation for teaching these subjects beyond high school courses. Here is ground for optimism. Certainly the preparation standards for the science teacher are much advanced in the last decade.

I realize that this group from whom my questionnaire is returned is a select group. Sixty replies received from science teachers in the smaller cities of Indiana and Wisconsin, teachers not included in the report already given, show that 72.6% are college graduates, 21% normal school graduates, and only 6.6% have only had a high school education. 71.2% have had courses in the science or sciences they are teaching in normal

school or college, and 15.9% are teaching courses in some one of which they have had no preparation beyond high school. The remainder (12.9%) are presumably teaching science in high schools without any preparation in any of the sciences they teach beyond the high school courses.

Out of the 104 teachers in the Central Association who reported, 57 are teaching only the one science, 29 are teaching two, 8 are teaching three, 5 are teaching four, 3 are teaching five, and 2 are teaching six. The teaching load in these last two includes in one case, biology, botany, zoology, general science, chemistry, and physics; in the other case, general science, physiology, botany, zoology, chemistry, and physics. Even the best prepared teachers in the larger high schools must be ready to teach two or more sciences. In the smaller schools the science teacher needs to be ready to teach all the sciences and often other subjects as well. Thus one teacher

Total Frequency		Chemistry, Physics and Gen. Science	Chemistry only	Biology with other science	Physics only	General Science only	Biology subjects only
61	Twiss, Science Teaching	*16*	7	*13*	8	9	8
58	Franklin's Autobiography	*16*	4	10	10	5	*13*
50	Vallery-Radot's Life of Pasteur	15	7	11	4	3	10
45	Eikenberry's Teaching Gen. Science	10	1	8	5	*10*	11
45	Mann's Teaching of Physics	14	7	6	13	5	0
43	Smith and Hall, Teaching Chemistry and Physics	*16*	*12*	8	3	2	2
38	Darwin's Life of Charles Darwin	8	3	9	4	5	9
34	Woodhull's Teaching of Science	12	3	6	4	5	4
30	Locy, Biology and Its Makers	4	3	8	1	1	*13*
27	Cajori's History of Physics	7	3	3	12	1	1
23	Venable, Short History of Chemistry	8	7	4	0	2	1
22	Thorpe's History of Chemistry	5	8	4	3	0	2
19	Brownell and Wade, The Teaching of Science and the Science Teacher	3	5	6	1	2	2
19	Thompson, Life of Michael Faraday	7	3	4	3	2	0
18	Rusk, How to Teach Physics	8	0	4	4	1	1
16	Thorpe, Life of Joseph Prestley	5	5	1	0	2	3
15	Roscoe, Life of John Dalton	6	3	3	0	3	0
12	Libby, History of Science	3	2	2	1	1	2
10	Sedgwick and Tyler, History of Science	2	2	2	1	1	2
	Average	6.9	6.5	6.2	4.9	4.6	4.2

reports from a Wisconsin city that he teaches arithmetic, algebra, geometry, physiology, biology, physics, penmanship and American history, in all eight periods per day. Three-quarters of the high schools in such states as Ohio, Indiana, Illinois and Wisconsin, are four-teacher schools, in which the science teacher must handle all the science. Evidently he needs broad preparation.

Nineteen books were listed on the questionnaire and teachers were asked to check the ones they had read. They are given in the order of the frequency with which they have been read, the first having the most readers.

Teachers of physics and chemistry have, on the average, read 7 of these books.

Teachers of chemistry, physics and general science have read 6.9.

Teachers of chemistry, 6.5.

Teachers of biological subjects together with one or more non-biological, 6.2.

Teachers of physics, 4.9.

Teachers of general science, 4.6.

Teachers of a biological subject or subjects, 4.2.

The average for all is 6.02, a surprisingly good showing on so brief a list. Two teachers had read none of these books; one had read 15, the maximum.

Brownell and Wade's, The Teaching of Science and The Science Teacher has already been read by 19 out of the 104. and Rusk's How to Teach Physics by 18, though these books were only published last autumn. The general histories of science are not popular with science teachers, and in only one group, the teachers who are specialists in one biological subject only, does a history of a subject stand first in importance. In four of the groups a book in the teaching of the special subject or of science in general leads the list.

Motion Pictures in the Teaching of Junior High School Science

By J. T. Shriner,
Latimer Junior High School, Pittsburgh, Pa.

I. *Why use visual aids in the teaching* process of Junior High Science

"The rate and quality of learning are improved by an increase in the number of senses used."—Caldwell.

Our education has become one of many words. We do not wish to reduce the use of reading or language, but the omission of experiences which involve touch, taste and sight are neglected in our modern education. We interpret life situations by the means of our five senses. From these senses we know what to do and what not to do. Then why should we fall into a conventional education of words. The textbooks are written by standardized word methods, the teacher teaches by standardized word methods, and the pupils are expected to learn by those methods or fail in the subject. Some pupils are eye-minded. They must see the process by picture or the actuality. The slide, film or chart will help these pupils to keep pace with ear-minded ones. Seeing is believing.

II. *Why and how should a motion picture* schedule be carefully chosen for class use?

We have found it is necessary for the teacher to know a film and prepare the lesson just as carefully as he would from a textbook. We would not expect a teacher in science to read a textbook through to a class. Neither would we expect a teacher to turn the picture machine over to the janitor with the order to run three reels on "Coal" while he visited the office on important business. The film should be adjusted to the course of study and made to correlate to the aims of the subjects which are being taught. The film should be taken to the classroom. The real mind-developing study is done there. Concentration and attention does not lend itself well to the auditorium presentation. The assembly may well be used as a censor of new films. However, another method of selecting a film program was tried at Latimer Junior High School, which is as follows. In the fall of 1923 an extra-curricular activities club was organized to review films. Any of the so-called educational films was shown at that hour. The club

membership consisted of two classes of pupils, "Once Overs" and the "Spotters." After the film was shown, the writer asked the club of about one hundred members the following questions: 1. Do you like this reel? 2. What do you like about it? 3. Would you like to see it in class? 4. What subject would you like to see it placed under? 5. What did you learn that you did not already know? 6. Would you like to see it again? Certain pupils, about two in number, recorded the answers. This information concerning the film was known as the "Once Overs." A second group of pupils, about six in number, were recording the answers to these questions: 1. What percentage of the picture is sub-titles, still pictures, motion pictures, and length of the reel? 2. Why do you think this would be a good motion picture for class use? 3. What objections have you to it for class use? 4. What subject would it supplement? What makes you think so? 5. Is it simple enough for class use and why? 6. Is it suitable for class use and why? 7. How many days would you take to show it and why? The answers to each of these questions were recorded by each of the six pupils on a "Spotter's Card." Many films were eliminated by this censoring. The accepted films were reviewed by a third class which comprised teachers of the subjects in which the films were assigned. Tests were worked out on the basis of the information contained in the film. The tests were as follows: True and False, Completion, Multiple Choice, and a Review of a Review. If the film was satisfactory to all three classes it was shown for the first time in the regular classroom. In this manner the first motion picture schedule was set up for the following semester. This method is still used to enrich the program. That is, if a new film is found better suited in the couse of study than one already adopted, a substitution is made. The motion picture schedule is as follows:—

MOTION PICTURE SCHEDULE.

Second Semester 1925-26.

7-B *Science*

1. Earth and its Neighbors

Film	*First day wanted*	*Last day wanted*
Birth of the Earth	2-5-26	2-12-26
Etc. Etc.		

2. Continuation of Nature Study

Film

Babies of Wild Animals — 4-2-26 — 4-9-26
Etc. Etc.

7-A *Science*

1. Forestry

Film

Transplanting Big Trees — 2-5-26 — 2--12-26
Etc. Etc.

2. Farming

Film

Scientific Stock Farming — 3-12-26 — 3-19-26
Etc. Etc.

8-B *Science*

1. Foods

Film

Our Daily Bread — 2-5-26 — 2-12-26
Etc. Etc.

2. How Animals Live and Work

Film

Inside Out — 4-9-26 — 4-19-26
Etc. Etc.

3. How Plants Live and Work

Film

Luther Burbank — 5-7-26 — 5-14-26
Etc. Etc.

8-A *Science*

1. Construction of the Eye

Film

How we See — 2-5-26 — 2-12-26
Etc. Etc.

2. Construction of the Ear

Film

How we Hear — 2-19-26 — 2-26-26
Etc. Etc.

Film

3. Breathing, Heart, Teeth, First Aid, etc.
Etc. Etc.

9-B *Science*

1. Building Our Home

Film

The Story of Concrete — 2-5-26 — 2-12-26
Etc. Etc.

2. Lighting Our Home		
Film		
The Benefactor	3-5-26	3-12-26
Etc. Etc.		
3. Heating Our Home		
Film		
The Story of Coal	4-16-26	4-23-26
Etc. Etc.		
4. Pittsburgh Water Supply		
Film		
The Water Supply of a Great City	5-28-26	6-4-26
Etc. Etc.		
9-A *Science*		
1. Transportation		
The Story of the Gasoline Engine	2-5-26	2-12-26
Etc. Etc.		
2. Communication		
Film		
The Wizardy of Wireless	3-12-26	3-19-26
Etc. Etc.		
3. Man's Place in Nature		
Film		
How Life Begins	5-7-26	5-21-26
Etc. Etc.		

III. *How should a film be presented to a class.*

The use of the motion picture in the public school today has been retarded by the type of pictures selected and the use to which they have been put. Some definite method in presenting this visual material should be as carefully followed as in oral presentation. If the film does not merit a place in the class activities it should not be used. The film deserves more recognition than it gets in most schools, but it does not justify the time and money demanded for it by some teachers. A poor film lesson is worse than a lesson without a film. Another element which enters into the method is the showing only one reel or part of it in a recitation period. In this manner a teacher should conduct an illustrated recitation effectively. It should arouse the pupil's curiosity, hold his interest, and guide his observation into the working out of life situations, so that the process may not be merely entertaining and

time-killing. As, for example, the following will illustrate one type-study; assuming the project is No. 94, "The Story of the Gasoline Engine," of three reels. The problem is: How does the gas-engine work. (Two hundred feet of the first reel was used.) This part was used as an introductory lesson. The titles of the film used are as follows:

Looking inside of one of the cylinders it will be seen that seven fundamental parts in the motor controls the development of power.

Cylinder
Piston
Connecting Rod
Crankshaft
Exhaust Valve
Intake Valve
Camshaft

The piston moves up and down four times to every explosion of gas. Each full movement is called a "stroke." The opening and closing of the valves is controlled by the crank-shaft. During the suction stroke the inlet valve opens and gas is drawn into the cylinder.

During the compression stroke both valves are closed—the gas is compressed in the upper part of the cylinder.

A spark occurs between the points of the spark plug. The compressed gas burns and expands, forcing the piston downward.

During the exhaust stroke the exhaust valve opens—the burned gas is expelled from the cylinder.

These four strokes are termed cycle.

After the showing of the reel, a multiple Choice Test followed, based on the above titles. The purpose of this test was to arrange the information from easy to hard. Also to eliminate the material which needs no formal classroom instruction. The test is as follows:

MULTIPLE CHOICE TEST.

Rank Order of Difficulty.

1. The gas is compressed in the upper part of the piston, cycle, cylinder, camshaft.

2. The valves are both closed during the compression, suction, exhaust, piston stroke.

3. The compressed gas burns and expands forcing downward the cylinder, spark-plug, exhaust valve, piston.

4. Each movement of the piston is called cycle, stroke, bore, crank.

5. The four strokes of the piston are called camshaft, cylinder, motor, cycle.

6. The opening and closing of the valves is controlled by the piston, camshaft, cylinder, crankshaft.

7. During the exhaust stroke the intake valve, exhaust valve, piston cylinder, opens.

8. The burned gas is expelled from the piston, cylinder, cam, stroke.

9. The piston moves up and down to every explosion of gas 2, 4, 6, 8 times.

10. The inlet valve is open during the compression, suction, exhaust, ignition stroke.

SCORE.

Question	Total pupils missing each question	Per cent missing each question	Percentile score
1.	00.00	00.00	00.00
2.	1	3.84	20
3.	1	3.84	20
4.	2	7.69	26
5.	2	7.69	26
6.	3	11.53	30
7.	4	15.34	33
8.	4	15.34	33
9.	7	26.92	39
10.	10	38.46	45

Total pupils 30. Questions Nos. 1, 2, 3, 4, 5, 6, need no formal class instruction.

IV. *What are the limitations of motion pictures in the classroom?*

Visual Education lays the foundation for thinking, but to carry on the thinking process itself, language must follow. The film should be followed by recitation, demonstration, notebook work, and reference material. As in questions Nos. 7, 8, 9, 10. A film is not a substitute for good teaching and never can be. The film enriches the class activities.

V. *Certain pupils will be inspired to continue these studies into life situations beyond the Junior High School Science class.* Such as:

1. The Project—The gasoline engine. (Continuing the above study.)

a. The Problem—To determine the traits which are conspicuously possessed by automobile mechanics and absent in unsuccessful ones, and to determine the relative importance of these traits.

b. Procedure consists of four steps: 1. Interviewing seven classes of people all working in the automobile business—manager, superintendents, shop foreman, best mechanic, poorest mechanic, office man, employment manager, and a technical engineer. 2. Translating the information acquired in the interviews into terms of abstract traits, such as, accuracy, cleanliness, speed, courtesy, carefulness, etc. 3. Defining those traits in terms of trait actions. The trait actions of the trait "cleanliness" are: He is clean in the way he works. He wears clean overalls. He needs no one to tell him to wear clean overalls. He does not climb into a sedan with dirty overalls. He does not leave a dirty steering-wheel. At quitting time he leaves the tools and floor clean. He goes in and out of the car with seats covered. He keeps the record cards clean, so they can be read in the office. A poor mechanic wears a dirty shirt, sloppy dress, soiled teeth, everything dirty. A clean man will do clean work. He is clean personally; this will carry over into his work. "Cleanliness is next to godliness," etc.

Obtain a composite picture of seven classes of people by ranking the traits according to the frequency of mention, as:

	Traits	Number	Rank
1.	Accuracy	8	1
2.	Technical knowledge	8	1
3.	Thoroughness	8	1
4.	Cleanliness	6	2
5.	Speed	5	3
6.	Ambition	4	4
7.	Interest in work	4	4
8.	Etc., etc.		

c. Evaluation of Method. This analysis may be used by four classes of persons:

1. The public men know what constitutes the trait actions of a good automobile mechanic.

2. Automobile mechanics may know what is expected of them to be successful.
3. Employment managers may know what traits to look for in hiring automobile mechanics.
4. Administrators may know the trait actions of good automobile mechanics.

d. Results:

1. The public will co-operate better with the motor company. They will not take the wrong trait action of a poor mechanic as the policy of the company.
2. The automobile mechanic will strive to do those things which he now knows will make him do better work.
3. Employment managers will be aided in hiring better men.
4. Administrators will know what is expected of good mechanics.

The conclusion is as follows:

1. Visual aids should be used in the teaching of junior high high school science.
2. A motion picture schedule must be carefully chosen for use in the class-room.
3. A film lesson should enrich the regular class activities.
4. Motion pictures have limitations in the class-room.
5. Some pupils will be inspired to continue these projects into life situations.

The Science Teacher

By W. G. WHITMAN, University of Nanking.

MANY university and most normal school graduates will teach. Some of the university graduates made special efforts to prepare for teaching while in the university. Others find that teaching is the one opening that, for the time being, is offered to them. Of those who will teach, some will be asked to teach science. The science in a science course gives ample subject matter for one to teach science in the junior and senior high schools, but to teach science in a better way, and to do this with ease and satisfaction, special preparation of the would-be science teacher is necessary.

Who should prepare for science teaching?

If you have any inclination to undertake preparation for science teaching, it is well first to make a critical analysis of yourself.

1. Are you very much interested in science?
2. Are you skillful in experimental work?
3. Have you ability in devising experiments from limited equipment?
4. Are you willing to spend much time outside of teaching periods in preparation of laboratory and demonstration work?
5. In your required science work in the university or normal school have you been graded in the upper half of the class?
6. Have you a personality that would help make you a successful teacher?
7. Do you wish to teach science?

You cannot, of course, answer all of these questions by a definite "yes" or "no." However, if you think the answer is "yes" to all of them, you may proceed with courses in science and education with a good prospect of success as a science teacher. But if the answer is "no" to any one of the questions, or if you are inclined to answer "no" to several of them, you should plan other work for your future.

Subject-matter preparation.

Anyone who has taken, in college, the general chemistry, the general biology, and a general course in physics, has covered what we may call "the minimum essentials" in subject-matter for teaching general science. However, it is very desirable that he also take short courses in astronomy, earth science (physical geography), geology, hygiene and sanitation, meteorology, and history of science. One can, with this preparation, teach elementary courses in the special sciences in secondary schools, but he will find that a greater depth of training in each subject will be very helpful. For example, if he is to teach elementary chemistry some chemical knowledge gained from the advanced courses, qualitative analysis, quantitative analysis, and organic chemistry will give him a depth of knowledge and breadth of view in chemistry which makes chemistry mean

more to him. With this advanced training, even though he teaches none of the subject matter of these courses, he will be able to make elementary chemistry mean more to his pupils. Because of his greater familiarity with chemistry, it becomes more a part of himself. In teaching elementary pupils, however, the highly trained specialist must guard against using methods adapted to advanced students. Remember, there is a wide range in ability between the elementary school student and the senior in the university.

Professional preparation.

Teaching should be considered as much of a profession as the practice of medicine, and as a profession it requires special professional training. Courses in psychology and methods of teaching are of the utmost value to the teacher. Such books as Kilpatrick's "Foundations of Method" should be studied with diligence. In addition to general education courses, when possible, specific courses in training for teaching a particular science subject should be undertaken. In these specific science training courses the student should receive training in preparing suitable outlines of subject matter, drill in demonstration work and in apparatus making. Time must be given to the various teaching aids and to ways of economizing the teacher's time. Types of class work, purpose of laboratory work and methods of testing are important matters to consider. If a choice must be made between a general educational course and a course training to teach a specific subject, choose the latter as one which will give you the specific help you need to make your work a success. Then do some well directed reading of educational books to correlate with the teacher-training work in science.

Importance of the work.

There can hardly be any more important work for a university or normal school graduate to undertake than that of making the science courses in secondary schools real foundation courses in science. Not merely foundation courses for further work in college, but more important than this— foundation courses for living wholesome, healthful and industrious lives. The spreading of the knowledge of science and habits of scientific thinking among the masses of the people will do much to make life

easier, to make the path to health surer, and to bring to many a joy of living as yet undreamed of. There is a large civic responsibility upon the teacher of science, because science has within itself the potential elements of remaking one's environment. The teacher must strive, in a tactful way, of course, to show the pupils how they can use science to improve conditions which surround them. If practical uses of science are shown, interest will be increased in science. More science specialists will eventually be prepared in the universities, and they will give to the country more and better physicians, more and better engineers and technical men. Better industrial and commercial conditions always follow the development of science.

Science a messenger of truth.

Science imposes one obligation upon everyone who elects to teach it. Science itself teaches truth, and the teacher who does not teach science so that it leaves some moral imprint of this fact upon his pupil's mind, is negligent of his opportunities, yes, of his obligations. One of the important contributions that science, when rightly handled, can make to any nation is in the building of a worthy character.

Surface of Mars Like Desert Mountain Tops

IF Mars has any inhabitants, they must be able to get along on about one-twentieth of the water one finds on the tops of the semi-desert mountain tops in southern California. Dr. Charles E. St. John, astronomer at the Mt. Wilson observatory, told the astronomers at the annual meeting of the American Astronomical Society how he learned of the Martian drought by means of the spectroscope mounted on the great 100-inch telescope, the largest instrument of its kind in the world.

When light passes through a substance, certain colors are absorbed, and what these colors are can be learned by means of the spectroscope. Specifically, light passing through water vapor of a certain density will always be absorbed in the same way. By catching the light from the planet with the great reflector and analyzing it with the spectroscope, Dr. St.

John was able to determine the amount of moisture in the Martian atmosphere.

There was a possible source of error in the absorbing effect of water vapor in the earth's own atmosphere. This was corrected by taking spectrographic pictures of the sky. When the absorbing effect shown in these was subtracted from the total in the plates from the planet, the remainder represented the absorption of the atmosphere on Mars. This proved to be only five per cent as great as the absorption of the very dry atmosphere above the summit of Mt. Wilson, indicating that the surface of Mars must be highly arid.

Measured by the same method, the amount of oxygen on the neighboring planet also is relatively very low; according to Dr. St. John it is only 60 per cent as great as the oxygen supply on Mt. Everest, where exploring expeditions have had to resort to the use of oxygen tanks in order to keep alive.

Though deficient in water and oxygen, there is no doubt that Mars still possesses an atmosphere. E. C. Slipher, of the Lowell Observatory at Flagstaff, Arizona, showed that photographs made with red-light filters made the planet appear larger and showed greater detail than those made with blue-light filters. Red light is known to have greater powers of penetration through the atmosphere than blue; so that the photographs would tend to indicate the presence of an atmosphere on Mars.

Mars is more thrifty than the earth of the radiation it receives from the sun. Dr. C. O. Lampland, using the Coblentz radiometer, found that though Mars receives less energy from the sun, it absorbs all but 15 per cent of what it receives, whereas the earth reflects nearly half of the light and heat falling on it. The temperature of Mars, Dr. Lampland concludes, may not be greatly different from that of the earth. Dr. Lampland has also studied the planet Mercury with the radiometer, but finds Venus unapproachable because of its dense envelope of presumably cloudy atmosphere.—*Science Service.*

What Makes Water Flow Uphill?

State a paradox and people will stop and stare. Repeat it a thousand times and nobody will pay any attention.

The ascent of sap in plants is so commonplace an occurrence that we seldom stop to consider what a truly amazing thing it is. Here is an apparent contradiction of the law of gravitation going on all about us all the time. On every summer day, in every field and woodlot, water flows uphill, whether only a fraction of an inch in the humble mosses or a couple of hundred feet in a towering tree. A single full-grown maple or linden will evaporate from its leaves as much as a barrel of water in a single day, and this must of course be replaced by sap flowing up the trunk. The water sent into the air by all the plants combined, must be comparable in quantity with the water carried off by the rivers.

How the water gets uphill in the trunks and stems of trees and plants has long been a sore puzzle to scientists. Several theories have been proposed, none of them very satisfactory. Until recently the one most commonly favored was known as the theory of "capillarity," which assumed that the water rose in a stem much as oil rises in a wick, through the natural tendency of liquids to climb up in narrow tubes and crevices. The trouble was, however, that ordinary capillary attraction could not raise water high enough or fast enough to account for all the losses through evaporation and use within the plant. Then there was another theory that took into account a supposed pumping action by the roots, or a so-called "root pressure." This theory, however, was always very vague, and even those who claimed to understand it could not explain it very convincingly.

A comparatively recent development is a theory that seems to explain the phenomena and at the same time to be free from the objections that have overthrown the earlier ideas. This theory is largely the outcome of experiments by a British scientist, Professor Dixon. He found that by sealing a column of water in a glass tube and using appropriate experimental means, he could make the water carry a considerable weight without breaking. Ordinarily, of course, we think of a stream of water as a thing unstable as a rope of sand, but the trick seems to lie in getting rid of all the air; for when this was done the water column could support a strain of several hundreds of pounds per square inch.

This is exactly the condition we find in the stems of plants. The fine fibers of which all stems are largely made up, are really exceedingly slender tubes in which water is carried as sap, but from which all air is excluded. These tubes are connected with each other from the ends of the remotest roots to the edges of the topmost leaves. It is thus possible to think of the evaporation from the leaves setting up a strain or pull on the water in the tubes, which is transmitted as through a system of slender silver wires, drawing the water up as rapidly as it is needed, and even reaching out into the soil in contact with the roots and obtaining a fresh supply from outside.

—Science Service.

Climatological Records may be Depended Upon

Typical of a large number of people who have read supposedly scientific articles on climatic "cycles," is a recent correspondent of the Weather Bureau of the United States Department of Agriculture. This man had about made up his mind to invest his savings in a farm in one of two Middle West states, when someone filled him with panic by the statement that "next winter there would be a killing freeze, disastrous to crops." Ignoring the carefully compiled data already sent him by the Weather Bureau, giving him full information about the climate of these two states for a great many years past, this correspondent wanted the bureau to confirm the rumor that he had heard.

The Weather Bureau has, up to the present time, no authoritative information about "cycles" or other phases of long-range forecasting on which to base statements or opinions. It has complete climatological data for a great many places in the United States, consisting of tabulated weather records extending over long periods of years, showing the average and extreme temperatures and other meteorological facts of value and interest. This information indicates the general climate of a region, its suitability for agriculture or other industries, its drawbacks, and its advantages. Nothing is prophesied, but there is no reason to suppose that any climate is going to vary radically from its recorded behavior during the past 40 or 50 years.

The prophecy that the present winter, 1925-26, would be extraordinarily cold seems to have been a mistake on the part of those who made it, for on the whole the winter has been a little warmer than normal. In view of such errors, it would seem better for those, like the correspondent referred to, who contemplate a change of residence, to rely more on past records than on forecasts.

The Part Drier Plays in Paint

It is a well known fact that linseed oil alone dries very slowly. In paint its drying is sometimes accelerated by the pigment used. Litharge, red-lead, and white-lead to a lesser degree, fall into this class of pigment. But for the purpose of bringing the drying period within practical limits liquid drier is added.

A drier is a metallic compound of linseed oil or rosin. termed a resinate or linoleate, as the case may be, to which some linseed oil and turpentine or benzine is added. Those metallic compounds most extensively used contain lead and manganese; although cobalt, nickel and iron are sometimes included. Driers made from rosin (resinates) are generally considered inferior in quality to those made from linseed oil, which contain linoleates.

When we speak of paint drying we really mean that the linseed oil is absorbing oxygen. The oil, on drying, forms a solid, tough, leathery substance, in which the pigment is embedded. This combination gives a film that protects the surface to which it adheres.

Linseed oil does not evaporate in the way one might suppose but actually gains in weight while it dries, by the absorption of oxygen. The drier carries the oxygen of the air to the oil at a rate faster than normal, but plays scarcely any other part in the drying process.

The metallic ingredient in the drier is capable of forming two compounds with oxygen. One of these compounds has a surplus of oxygen which is immediately passed over to the linseed oil—a continuous process that keeps up at a rapid rate until finally the linseed oil has absorbed its natural limit of about 20 per cent of its own weight in oxygen. If the action of the drier stopped at this point all would be ideal but unfortunately it does not. The drier keeps right on forcing oxygen into the oil, though at a much slower rate, of course. It is doubtful if this action ever ceases entirely, and if too much drier has been used the paint film will be harmed, because the continued addition of oxygen now actually "burns up" the paint film.

It is for this reason that just the right amount of drier should be added, as too much will cause the paint film to deteriorate at a greater rate than normal and too little will mean unnecessary prolongation of the rate of drying.

—From *The Dutch Boy Painter,* Oct. 1925.

How to Make a Record of a Lightning Stroke

Although many accounts have been written of the effects produced by lightning, important details are usually omitted, making a scientific analysis of the available information difficult. It is desirable that there be placed on record in an appropriate institution, such as the Weather Bureau of the United States Department of Agriculture, any facts relating to lightning stroke.

It is necessary in making such observations to note carefully many details that often escape attention. Assuming that the object struck is a tree, a plan of the surroundings showing the location of various other trees and objects, their heights, and the position of fallen pieces of the tree struck, should be made. If possible, photographs should be taken from different positions, showing the nature of the damage. All holes, furrows, and other irregularities on adjacent ground should be noted, and their size included. If the tree is splintered, notes should be made of the positions of the most distant splinters, as well as of all the large ones. The nature of the splintering should be noted, as an indication of the path of the lightning. Punctures of the bark should be searched for, even if they are very small. They often show whether the tree was affected by a mechanical force acting from within outward, or the reverse. Their borders may be scorched. The nature and location of all damage to the bark and sapwood should be noted. Nothing should be moved until everything of interest regarding the original effect of the stroke has been recorded. Then, if practical, the tree may be thrown, so that the roots may be examined and the nature and extent of injury to them, if any, noted. Exhibits should be collected, carefully labeled and preserved, if it is felt that the information obtained can be made more useful by that means.

The Weather Bureau will be glad to make additional suggestions to those who are interested in making accurate records of the effects of lightning strokes.

Available Motion Picture Film

The goose that laid the golden egg figures in a two-reel educational film, "Harvesting Uncle Sam's Timber," just released by the United States Department of Agriculture. The futile sacrifice of the bird of Aesop's fable is paralleled with the fate of our forests under the wasteful system of logging that has prevailed hitherto in the lumbering industry, and the practical system of forest management followed in our national forests is cited as proof that we do not need to cut down our forests to get the most out of them.

The body of the film portrays the system followed in selling mature timber from the national forests. Beginning with advertising of a unit for sale by a forest supervisor, the deal is followed through the letting of the contract to the highest bidder, the marking of approximately 65 per cent of the stand for cutting, with due allowance of thrifty young trees and seed trees for the maintenance of the forests, and logging under the supervision of the forest ranger.

It is pointed out that under the restrictions imposed in lumbering on the national forests, a perpetual supply of timber is assured without the destruction of the forest,—in a word, to get the golden eggs you must take care of the goose.

Copies of this picture may be borrowed for short periods, or may be purchased at the laboratory charge. A complete list of the department's films, with information on the method of distributing them, is given in Miscellaneous Circular 27, which may be obtained on application to the Department at Washington, D. C.

"What the Forest Means to You," a two-reel picture showing the fundamental relation of the forest to the maintenance of our civilization, has just been released by the United States Department of Agriculture. The picture points out that the very leaves of the forest are of prime importance to civilization, through their bearing on soil fertility and upon the control of the water supply, and goes on to show the economic importance of the forest in various other ways. An important feature of the picture is a series of scenes devoted to the activities of a lumbering concern that is handling a tract of timberland in Arkansas in such a way that the forest will keep the mills of

the concern running perpetually. Scenic shots of exceptional beauty lend interest to this picture, as well as some scenes showing woodworking activities now rather out of the ordinary, such as the making of split-bottomed chairs in the Ozarks, and "riving" shingles with mallet and frow.

"The Story of Dynamite" is the title of the latest addition to the list of educational motion picture films distributed by the Bureau of Mines for the purpose of visualizing various phases of the mining and allied industries. The film, which was produced in co-operation with one of the larger explosives manufacturing companies, depicts vividly modern methods of the manufacture of high explosives, and illustrates the importance of dynamite in the mining, industrial and agricultural life of the country. The mining and transportation of Chilean nitrate, the manufacture of wood pulp used as an absorbent, the various chemical processes involved in the preparation of ammonium nitrate and the conversion of sodium nitrate into nitric acid, the manufacture of nitroglycerine, chemical testing of the various ingredients, methods of transportation, and various uses of high explosives are included in the film. Copies of the film may be obtained from the Bureau of Mines, 4800 Bureau of Mines, Pittsburgh, Pa.

A new educational motion picture film called, "Through Oil Lands of Europe and Africa," has just been completed by one of the larger petroleum producing companies for inclusion in the library of industrial films distributed by the Bureau of Mines. This film is divided into three parts, of three reels each. The first part features the oil industries of Germany, France, Spain, Morocco and Algeria; the second deals with the oil fields of Italy, Hungary, the Danube, and Roumania; while the third part features the Polish and Egyptian fields. In addition to showing the operations of the petroleum industry in the countries named, many interesting scenes portraying the life and customs of the inhabitants of the regions are shown. Any of the three parts of the film may be obtained from the Bureau of Mines, Pittsburgh, Pa.

The business of blasting stumps, breaking up large boulders, blowing out drainage ditches, and otherwise bringing rough

lands under the plow, through the medium of explosives, is pictured in a new United States Department of Agriculture educational film, "Dynamite—Concentrated Power."

The film is a contribution from the Bureau of Public Roads. It is designed to show farmers safe methods of using dynamite, and contains many details of blasting operations. The acts of punching holes, loading, priming, and exploding the charge, have been transferred to the screen through the medium of the "close-up." Both the safety-fuse and electric methods of blasting are included.

The use of explosives on farms is said to be rapidly increasing. It is estimated that about 20,000,000 pounds of explosives are used annually for agricultural purposes. The film aims to encourage farmers to avail themselves of the tremendous power concentrated in dynamite and to insure proper handling of the explosives. Scenes showing the actual blasting of stumps, boulders and ditches make a spectacular picture. The blasting of a ditch 400 feet long and 6 feet deep in a single shot, and slow-motion pictures of the blasting of a huge Douglas fir stump, are features of the film.

"Dynamite—Concentrated Power" was photographed in Virginia, North Carolina, Michigan and Washington. The film was adapted for general use throughout the United States. It is one reel in length. Copies may be borrowed for short periods or may be purchased at the laboratory charge. A complete list of the Department's films, with information on the method of distributing them, is given in Miscellaneous Circular 27, which may be obtained on application to the Department at Washington, D. C.

The following films dealing with rubber are now available:

"How to Make a Rubber Tire"—1 reel—Ford motion Picture Laboratories, Detroit, Mich.

"Rubbering in Selangor"—1 reel—National Non-Theatrical Motion Pictures, New York, N. Y. (Rubber Industry in the Malay States.)

"Rubber of Yesterday"—1 reel—Goodyear Tire & Rubber Co., Akron, Ohio.

"Fiji Does Its Bit"—1 reel—Pilgrim Photoplay and Book Exchange, Chicago, Ill.

"The Conductor"—1 reel—General Electric Co., Schenectady, N. Y. (Transformation of raw materials into finished lamp-cord.)

An interesting 1-reel picture, "Science of a Soap-Bubble," may be obtained through Pictorial Clubs, Inc., New York, N. Y.

"The Amber Soul"—1 reel—A study of some of the properties of electricity and the making of storage batteries.

"The Friction Ball"—1 reel—Experiments with a ball of sulphur.

"Volta's Discovery"—1 reel—Evolution of study of electrical current, and the perfection of electrical battery.

"The Lone Asian Traveler"—1 reel—Cheese-making interestingly presented.

"The Better Way of Milking"—1 reel—Proper methods analyzed.

"The Story of a Spark Plug"—2 reels—Its manufacture and its importance in good performance of a car.

"The Fountain of Youth"—2 reels—History of the bath, from ancient to modern times.

May be secured free (transporting charges only) upon application to Atlas Educational Film Co., 1111 South Boulevard, Oak Park, Ill.

"The Making of Steel"—2 reels—International Harvester Company.

"A Horseless Carriage to a Horseless Age"—1 reel—Studebaker Corp., South Bend, Ind.

"The World of Paper"—2 reels—General Electric Co.

Book Reviews

A very valuable series of charts has been prepared by Professor H. A. Webb, of George Peabody College for Teachers, Nashville, Tennessee. These charts give graphically the distribution of the various sciences in general science texts. and the comparative importance of these various science fields. Eighteen texts have been studied, four pages of typewritten material explaining these charts and giving suggestions for their use accompanying the charts. They are for use in Teachers' Colleges, Normal Schools, and training schools, where classes are studying curricula, criteria for text book selection, materials and methods of science teaching, etc. The guiding sheets contain questions which guide the student in an examination and use of the charts. These may be had from Professor Webb at cost, which is 10 cents per set; 3 sets for 25 cents.

A pamphlet called *Nature Trails: An Experiment in Outdoor Education*, by Frank E. Lutz, has just been published by the American Museum of Natural History, New York, which will be of interest to all teachers of Nature Study. This experiment is a new idea in museum work and something which will give many valuable suggestions to teachers of Nature Study for school projects along similar lines.

Chemical Calculation—Jaffe—159 pages—$1.28—World Book Company.

This book is designed to strengthen the instruction in chemistry in secondary schools and first year college, where it is weak—in chemical arithmetic.

With this book, teachers will be able to give students of general chemistry a thorough training in chemical calculations. It develops a method of attack on problems by classifying them according to types, explaining the method of solution, and giving numerous examples after each new step has been presented. It furnishes abundance of problem material. There are over a thousand problems to meet all the required needs of high school and first year college classes.

Following the progressive type study of problems, the author devotes over 50 pages to problems classified according to lesson assignments. Each important topic in chemistry is given a separate page. The essential reactions under that topic are listed, and then a graded list of problems, embracing all the types generally taught, is given.

This book should relieve the teacher of a heavy load and at the same time to enable students to strengthen one of their outstanding weaknesses. It should also make clear the importance of quantitative data in chemistry and help motivate what is considered one of the least interesting parts of chemistry.

Elements of General Science with Experiments—Caldwell and Eikenberry—600 pages—238 illustrations—$1.68—Ginn and Company.

The topic headings of this text are the same as the old Caldwell and Eikenberry text, but it has been completely rewritten. The work on gas and electric engines, radio, and vitamin studies has been brought up to date. The text includes more material, because it is the author's belief that general science teachers are now better prepared and are, therefore, able to make selection of material suitable for their own use.

Seventy-eight new illustrations are included. The vocabulary is that of the standard eighth grade vocabulary, except where scientific words are needed and are desirable additions to the vocabulary of an eighth grade pupil.

"It is the object of this course to develop a usable fund of interesting and worth-while knowledge about common things. It is also its object to develop helpful and trustworthy habits of thinking about and of judging the common experiences which fall within the fields of science."

There has been no attempt at a unity of any particularly special science, but the work is built around topics and unity secured by logical interrelations between the topics which compose the course.

At the beginning of each chapter, a list of questions for discussion is given. The laboratory work is distributed throughout the text.

Experimental Science I, Physics, Heat, Light and Sound—Brown—530 pages—424 cuts—$2.50—The Macmillan Company.

This is one of a series of texts covering Physics, Chemistry, and Electricity and Magnetism.

The work in Physics is divided into six sections, three of which are covered by this volume. The book contains a great deal of subject matter and considerable mathematics. The preface of this book states that it has been prepared as a text book for schools which devote one complete school year to the study of these portions of physics. It is considerably more advanced than the material usually given in high school texts and with very little descriptive matter.

It is written and published in England, and seems more adapted to the type of work done in English schools.

The Gist of Evolution—Newman—154 pages—$1.75—The Macmillan Company.

This volume is an exceptionally readable one from the point of view of the man untrained in science.

The author's aim was to write a brief and clear statement of evolution for popular use.

The author starts from the controversy which resulted from the Scopes trial, and proceeds from that to define the theory of evolution, and to tell of the various evidences in support of it. A very interesting chapter is, "What Evolution Is and What It Is Not." In this chapter he speaks of many of the ideas about evolution which are held by so many people and which are not part of the evolutionary theory at all.

The first three chapters of this book should do much to reconcile the conflict between evolution and religion which exists in the minds of many.

Seeing America, Book II, Mill and Factory—Pitkin and Hughes—333 pages—illustrated—The Macmillan Company.

This book deals with our industrial life. It is written in fictional form, concerning itself with the adventures of two boys. This book is intended to be used in connection with geography work. Such industries are covered as the making of moving pictures, sugar refining, flour, rubber, meat packing, paper, glass, and many others. At the end of each chapter are given questions and study helps.

Ice Ages, Recent and Ancient—Coleman—283 pages—illustrated—$4.00—Macmillan Company.

This is a very fascinating and complete book. The subject has a very wide interest, and although much has been written about it this literature is very scattered. This book is of great value as a guide to this literature, and as giving personal descriptions of deposits referred to glacial action in Europe, South Africa, India, Australia, and South America.

Graded Exercises in Chemistry—Mendel—106 pages—53 cts.—Globe Book Company.

This is a series of questions and problems so graded that they develop complete lesson units.

They can be made very useful for the assignment of lessons as well as for review. These questions have been selected from those used by the author in his classes as mimeographed lists. These have then been revised and reorganized as actual use seemed to indicate necessary.

There are also a number of specimen examination papers given.

Chemistry and Its Uses—MacPherson and Henderson—460 pages—269 illustrations—$1.60—Ginn and Company.

This is a revised edition of the MacPherson and Henderson Chemistry text. It stresses the application rather than the abstract principle, at the same time not losing sight of the principles and the way in which pure chemical knowledge may be of use to the world. "The main object of the course in Chemistry must always be to train young people to think and to imagine in the realm of chemical facts and laws."

The chapter on the Periodic Law gives the latest discoveries as to the structure of the atom, and explains oxidation, reduction, and valence in terms of the electron. Both the Lewis-Langmuir and the Bohr conceptions of the structure of atoms is given.

Outline of Plant Geography—Campbell—392 pages—368 illustrations—Macmillan.

This book gives a description of the most notable features of the vegetation characteristics of the more important botanical regions. The book is based on notes, specimens, sketches and photographs, accumulated by the author during more than thirty years of travel throughout many parts of the world.

A Numerical Drill Book on Physics—Taylor—95 pages—$1.00—Ginn & Company.

This is a collection of graded problems in physics. The subjects covered are mechanics, heat, magnetism and electricity, wave motion and sound, and light. Those parts of physics which require more problem work are emphasized. Therefore, the space allowed other different portions of physics is not uniform, but conflicts with the needs of a teacher. The problems are stated in algebraic form, and then a data table containing four sets of figures is given. The answers are also given. The work is of college grade.

Investigations in the Teaching of Science—Curtis—341 pages—$2.50—Blakiston's Son and Co.

This is a digest of 70 investigations of science teaching in elementary and secondary schools in two groups: The Learning Studies, and The Curricular Studies. A brief statement of the problem, a description of the method or technique used, and a detailed list of findings is given. The arrangement is chronological with respect to order of publication. This much of the book alone is valuable to the science teacher as a guide to the professional literature. Additional features make it valuable also as a text-book for graduate students. There are problems and questions on each of the investigations, and also some general exercises for the graduate student to work out. Grouping of the studies by method, technique, subject, etc., appear in the index. This is one of a series of "Text Books in Science Education," edited by Dr. S. R. Powers of Teachers College.

How to Teach General Science—Frank—238 pages—$2.00—Blakiston's Son and Co.

The best review of this book is a list of its chapter headings. They are as follows: Brief History of Secondary Education in America, Brief History of Science in Secondary Education, The Growth of General Science, Criticisms of General Science and General Science Teaching, The Aims of Education and the Role of Science in their Realization, The Subject Matter of General Science, General Science Text-books, Traditional Methods of Teaching Science, Supervised Study, The Project Method, The Laboratory End of General Science, Efficient Classroom Technique, Some Special Problems in General Science Teaching, How to Create and Maintain Interest in General Science, The Measurement of Results, The General Science Library, Suggestions to the Inexperienced Teacher, The General Science Teacher, Special Teaching Aids. This is one of a series of "Text Books in Science Education," edited by Dr. S. R. Powers of Teachers College. The need which this book fills is expressed in an introduction by Dr. Powers as follows: "The major difficulty which teachers face, and probably the one which more than any other jeopardizes the success of the work, results from lack of familiarity with what may be called the point of view of the course. Neither the aims nor the methods nor the outcomes of instruction in General Science are the same as have been defined for the special sciences. It is evident that the need is urgent for a clear, comprehensive interpretation of the point of view of General Science."

Chemical Calculations—Jaffe—In New World Science Series, edited by John W. Ritchie—159 pages—$1.28—World Book Company.

This book is designed to strengthen the instruction in chemistry in secondary schools and first year college, where it has been shown to be lamentably weak,—in chemical arithmetic. An investigation conducted by Professor Powers, of Teachers College, Columbia University, which the author cites in his preface, showed the inability of first year chemistry students to handle simple mathematical problems in chemistry. Yet college entrance examinations and such examinations as the New York State Regents, parts of which Mr. Jaffe includes in his book, show a high proportion of questions requiring mathematical calculations.

This book develops a method of attack on problems by classifying them according to types, explaining the method of solution, and giving numerous examples after each new step has been presented. It furnishes an abundance of problem material. There are over a thousand problems. Following the progressive type study of problems, the author devotes over 50 pages to problems classified according to lesson assignments. Each important topic in chemistry is given a separate page. The essential reactions under that topic are listed, and then a graded list of problems, embracing all the types generally taught, is given.

A Manual of Normal Physical Signs—Blanton—215 pages—$2.50—C. O. Mosley Company.

This is a handbook, in notebook form, of physical signs used in medical diagnosis. Its object is to separate the normal signs from the pathologic signs in order to make this phase of the subject more clear to the beginner. This book would be of use to medical students only.

The Music of the Spheres—Grondal—334 pages—profusely illustrated.

This is a book that will be of great help to many General Science teachers. It gives a complete discussion of the various constellations, giving not only diagrams of the most important stars, but sketches showing the complete figures as imagined by the ancient astrologers. The legends about these various constellations are also given, which makes it a great aid in teaching this subject in the younger grades.

All of the information one could wish is in this book, and a wealth of supplementary material besides, written in a most interesting and entertaining manner. The planets, the earth, the moon, meteors, and the sun are given special attention. It contains 24 full page plates, besides numerous diagrams and sketches. There is a pronouncing dictionary and a bibliography.

The Kinetics of Chemical Change in Gascous Systems—Kinshelwood—204 pages—4.25—Oxford University Press, American Branch.

This text deals with those phenomena of chemical change which may be interpreted in terms of the kinetic theory. The book attempts to present a perspective of the whole field, rather than details. It is of college grade and a considerable knowledge of mathematics is needed in order to understand it. The chapter titles are: Bimolecular Reactions, Energy of Activation, Termolecular Reactions, Unimolecular Reactions, The Kinetics of Heterogeneous Reaction, and Activation in Heterogeneous Reactions.

Scott's Polar Journey and the Weather—Simpson—31 pages—85c—Oxford University Press, American Branch.

This is a paper-covered pamphlet of the Halley lecture, delivered in May, 1923. This pamphlet discusses the weather phenomena encountered during Scott's Polar journey.

The Relation of Nature to Man in Aboriginal America—Wissler—248 pages—51 illustrations—$3.50—Oxford University Press, American Branch.

This text attempts to show the relation between man and nature by a study of the geographic distribution of certain traits of material culture, social traits, and somatic traits of the American Indians. These studies of specific distributions are taken up with the belief that distribution is a direct expression of man's adjustment to nature and that this study will reveal whatever processes are involved. Such cultural traits are studied as the distribution of stone collars, moccasins, outrigger canoe, etc. Social traits such as the sun dance, blood sacrifice, origin of pottery, and so on, are traced. From this data is worked out a diagramatic way of repressing these various trait distributions and loss for their diffusion.

General Inorganic Chemistry—Sneed—674 pages—129 cuts—$3.00.

This follows the general form in method and presentation of chemistry, and is of college grade. Chapters going into Thermochemistry, Ionic Equilibria, Colloids, Electrochemistry, etc., are so arranged that they may be omitted if desired without interfering with the unity of the course. In addition to illustrative cuts, full-page portraits of twelve famous scientists are given.

An Introduction to Experimental Embryology—DeBeer—148 pages—51 illustrations—$2.50—Oxord University Press, American Branch.

Some hundred and eighty pieces of work by various experimenters have been selected and arranged in logical order, from fertilization to the assumption of the adult form. It is of advanced college grade.

Open Doors to Science—Caldwell and Meier—410 pages—249 illustrations—Ginn and Co.

This book is built around major topics selected as being relatively universal in home, school and community. At the opening of each chapter a group of questions is given intended to bring out the experiences the pupils have had and to set up problems for later discussion and investigation. The material in the book has been tried out in many classes and in teacher-training classes, and is selected material which has been found to be suitable. Some of the subjects covered are: fire control, food requirements, household wastes, clothing, transportation, communication. The text and the demonstrations are so carefully illustrated that they may be taught by any upper-grade teacher without special training in the sciences. The experiments and demonstrations may be performed in any grade room, if there is no special laboratory available.

Self-Direction and Adjustment—Fenton—121 pages—$1.40—World Book Company.

This is a self-help manual for students, that makes use of psychological principles and applies to individual use the methods of measurement and adjustment. Most of the book deals with the principles of study and learning, covering conditions for effective study, and how to study. In the last two chapters the author takes up certain considerations regarding ambitions and ideals, and points out the value of self-analysis and self-direction in achieving them. The content of this book should interest the teacher, as the principles of mental hygiene which it takes up are of importance to everyone engaged in mental work.

How Insects Live—Wellhouse—428 pages—333 illustrations—$5.00—MacMillan.

First the various bodily functions of an insect, his means of protection, locomotion, digestion, circulation, reproduction, etc., are explained. A few particular species in each group are then selected for description as to special habits, etc. The emphasis has been placed on the biological phases of entomology, but a systematic background has been kept throughout. A key is given to a selected group of common insects, both in adult and larval forms, and a list of families is given for references.

The Work of the College Entrance Examination Board, 1901—1925—300 pages—$4.00—Ginn and Co.

The contents of this work are as follows: How the College Entrance Examination Board Came Into Being, by Nicholas Murray Butler; The College Entrance Examination Board, A Retrospect and a Prophecy, by Wilson Farrand; Has the College Entrance Examination Board Justified its Quarter-Century of Life, by Henry S. Pritchett; The College Entrance Examination Board, Pioneer in the Solution of Educational Problems by the Co-operation of Those Concerned, by Julius Sachs; A Brief History of the College Entrance Examination Board, by Wilson Farrand; The Art of Examination, by A. Lawrence Lowell. Lists of officers, members, a digest of publications, are also given. Points of interest are: Validity of College Entrance Examination Board Measures, page 53; Value of Written Examinations, page 163; Measuring the Performance of a Candidate, page 188; Trustworthiness of the Board Examinations, page 203; The Attitude of the Board Toward Innovations, page 204; Possibility of Lessening Fluctuations, page 213.

A Laboratory Guide for General Botany—Sager—205 pages—$1.25—P. Bakiston's Son.

This guide is intended for the use of students in their first course in universities and colleges, or other institutions of like grade. It is the third edition. There have been some additions and revisions, but no new plant types or exercises have been added.

Introductory College Chemistry—Gordon—688 pages—135 cuts—$3.80—World Book Co.

This is a college grade text book, prepared for those who have had no high school chemistry. The author has tried to introduce some educational principles which have worked out successfully in the fields of elementary and secondary education. The text is based on the project and unit study plan. Laboratory work is built into the text. A minimum number of mathematical problems has been provided.

First Lessons in Nature Study—Patch—285 pages—illustrated—Macmillan.

This is a very interesting book for quite young children. The type is large and the illustrations and drawings are good. Many of the fundamental ideas of biology are given in a very simple and understandable form. Many nature study facts are given in a very interesting manner about plants and animals of common occurrence. The book attempts to stimulate the pupil to observe for himself what is going on in the plant and animal world about him.

Science Articles in Current Periodicals

[These classified articles should make valuable supplementary reading for the pupils. In some cases the material is in such form that it would be too difficult for many of the pupils to abstract the matter for themselves. In such cases the article may be read by the teacher and passed on to the pupil in class. Such articles are starred. Articles for professional reading are at the end of the classified list.]

AGRICULTURE

Science Invades the Farm. Sci. Amer., July 1926, p. 23.
Agriculture in the Tropics. Sci. Amer., July 1926, p. 38.

ATMOSPHERE

How High Up? Sci. Amer., July 1926, p. 17.

ASTRONOMY

A Twenty-five Foot Eye. Sci. Amer., Sept. 1926, p. 174.
The Fondest Dreams of the Astronomer. Sci. Amer., Aug. 1926, p. 96.
Is Our Universe a Spiral Nebula? Lit. Dig., May 1, 1926, p. 24.
Hunting Comets. Pop. Mechs., June 1926, p. 893.
Our Debt to the Sun. The Guide to Nature, May 1926, p. 186.
The Amateur's Work in Astronomy. Sci. Mo., May 1926, p. 411.
Clusters and Nebulae. Sci. Mo., May 1926, p. 415.
Stellar Evolution. Sci. Mo., May 1926, p. 419.
The Great Outer Planets. Sci. Amer., May 1926, p. 304.
*The New Cosmology. Sci. Amer., May 1926, p. 310.
*The Properties of the Stars in the Solar Neighborhood. Sci. Mo., June 1926, p. 494.
How to Observe the Great New Sun Spots. Sci. Amer., June 1926, p. 267.
See also "EARTH."

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ATOMS
X-Ray and Atoms. Sci. Amer., June 1926, p. 386.
*An Atomic Picture of Duralumin and Its Crystal Structure. Jour. Frank. Inst., Apr. 1926, p. 465.

BAKING POWDER
The Story of Baking Powder. Jour. Chem. Educ., May 1926, p. 492.

BIOGRAPHY
The First Great Salesman of Science (Ben Franklin). Pop. Sci. Mo., Sept. 1926, p. 25.

BIOLOGY
The Triumph of a Turnip. (Science Playlet.) The Sci. Classroom, May 1926.

CARBON-DIOXIDE
Carbonic Acid Gas. (Experiments.) Sci. and Inv., Aug. 1926, p. 329.

COAL
*The Constitution of Coal. Ind. and Eng. Chem., June 1926, p. 649.

COLLOIDS
*How Many Colloids Have You Used Today? Jour. Chem. Educ., Apr. 1926, p. 438.

COMMUNICATION
Building a Talk-bridge Over the Sea. Sci. Amer., July 1926, p. 30.
The Magic Eye That Sees Across the Ocean. Pop. Sci. Mo., July 1926, p. 18.
See also "TELEPHONE."

DYES
*A Little Talk About Dyes. Report of the N. E. A. C. T., June 1926, p. 130.

EARTH
Is the Earth's Diameter Changing? Sci. Amer., July 1926, p. 13.
The World's Greatest Cataclysm. Sci. and Inv., Sept. 1926, p. 400.
The Great Earth-Moon Catastrophe. Sci. Amer., Aug. 1926, p. 109.
The Origin of the Earth. Sci. and Inv., May 1926, p. 18.
The Internal Heat of the Earth. Sci. Amer., June 1926, p. 370.

EARTHQUAKES
How Earthquakes are Located. Sci. Mo. May 1926, p. 455.

ELECTRICITY
The World's Most Powerful Machine. Lit. Dig., June 26, 1926, p. 20.

ENGINEERING
Latest of Our Great Bridges. Sci. Amer., July 1926, p. 28.
Types of Modern Bridges. (Pictures). Sci. Amer. Aug. 1926, p. 137.
Moving Mountains. Pop. Mechs. June 1926, p. 931.
Welded Buildings. Pop. Mechs, June 1926, p. 995.
A Tug of War with the Bottom of the Sea. Pop. Sci. Mo., June 1926, p. 18.

EROSION
Pirate Rivers and Their Prizes. Nat. Geog. July 1926, p. 87.

FOOD
Food Fallacies. Hygeia, June 1926, p. 305.

FRANKLIN, BENJAMIN—See "BIOGRAPHY."

GLASS
Glass That Will Bend. Lit. Dig., Apr. 24, 1926, p. 22.

GRAVITATION
Weighing the Earth. Lit. Dig. May 8, 1926, p. 23.

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A Foe Man Has Yet to Conquer. Pop. Sci. Mo. June, 1926. p. 23.
Health From Sunlight. Lit. Dig. Aug. 28, 1926, p. 20.
Malaria and the Mosquito Fish. Sci. Amer. May 1926, p. 296.

HEATING
What an Oil Burner Offers You. Pop. Sci. Mo. July 1926, p. 15.
Saving Coal with a Vacuum Cleaner. Lit. Dig. May 8, 1926, p. 22.

HYDRAULICS
The Romance of a Hydraulic Elevator. Sci. and Inv., May 1926, p. 17.

INK
*Printing Ink. Jour. Chem. Educ., Apr. 1926, p. 408.

INSECTS
The Butterfly Feathers. Lit. Dig., Juy 10, 1926, p. 20.
Insects' Wives Don't Coddle Lazy Husbands—They Kill them. Pop. Sci. Mo. Sept. 1926, p. 38.
Fighting Insects Foes. Pop. Mechs. July 1926, p. 97.

INVENTIONS
Old Patent Models. Pop. Sci. Mo. July 1926, p. 24.
What All Modern Industry Owes to Eli Whitney. Pop. Sci. Mo. July 1926, p. 33.

JELLY FISH
The Life of the Moon Jellyfish. Nat. Geog. Aug. 1926, p. 182.
Jellyfish—Living Draperies of Color. (Plates) Nat. Geog. Aug. 1926, p. 192.

LEATHER
The Chemistry of Leather Manufacturers. Jour. Chem. Educ. Aug. 1926, p. 857.

LIGHTNING
Why Lightning Strikes Trees. Lit. Dig. June 1926, p. 21.
*Lightning. Jour. Frank. Inst., Apr. 1926, p. 485.

LIGHT
Light—First Aid to the Movies. Pop. Sci. Mo., June 1926, p. 17.

METEORS
The Most Interesting Spot on Earth. Lit. Dig., Aug. 14, 1926, p. 21.

NATURE STUDY
Nature Faking. Sci. Amer., May 1926, p. 322.

OPTICAL ILLUSIONS
How Your Eyes Deceive You. Pop. Mech., Sept. 1926, p. 372.

PAINT
A Romantic Achievement in Industrial Chemistry. Sci. Amer., July 1926, p. 34.

PETROLEUM
Uncle Sam, Spendthrift. Sci. Amer., June 1926, p. 375.

PLANT PHYSIOLOGY
General Science—Plant Physiology (Experiments). The Sch. Sci. Rev., June 1926, p. 257.

POLLEN
Pollen Under the Microscope. The Guide to Nat., June 1926, p. 5.

POWER
Horse Power from the Tides. Sci. Amer., May 1926, p. 315.
*Latest and Future Developments in Power Generation. Jour. Frank. Inst., Apr. 1926, p. 431.

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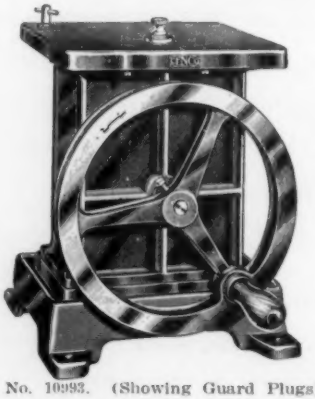

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(Because of the many magazines devoted to Radio alone, and the extensive departments devoted to this subject in most scientific magazines, radio articles are too numerous to list separately.)

RAYON

The Latest Member of Our Textile Family. Sci. Amer., Aug. 1926, p. 112.

REFRIGERATION

The Passing of Natural Ice. Lit. Dig., Apr. 1926, p. 25.

RUBBER

Rubber Made from Oil. Pop. Sci. Mo., July 1926, p. 26.

Home Grown Rubber. Lit. Dig., Apr. 24, 1926, p. 25.

SALT

Ancient Salt Mines of the Indians. Sci. Amer., Aug. 1926, p. 117.

SCIENCE

Pure Science Pays Its Way. Nation's Business, June 1926, p. 24.

SOUND

*Acoustical Research in Autoriums. Sci. Amer., May 1926, p. 298.

SUGAR

Sugar From Beets.Jour. Chem. Educ., Apr. 1926, p. 390.

SUN SPOTS

Do Sun Spots Affect the Earth? Lit. Dig., Apr. 24, 1926, p. 21.

See also "ASTRONOMY."

TELEPHONE

The Romance of the Telephone. Pop. Mechs., June 1926, p. 893.

TIME

The Story of Timekeeping. Sci. Mo., May 1926, p. 424.

VENTILATION

How to Keep Cool on Hot Days.

VITAMINS

*Ten Years of Vitamin Research. Jour. Home Econ., May 1926, p. 248.

WATER POWER

The World's Greatest Waterfalls. Nat. Geog., July 1926, p. 20.

WEATHER

Exploration of the Poles of Wind on Our Planet. Sci. Mo., May 1926, p. 453.

Weather from Kites. Pop. Mech., June 1926, p. 963.

See also "SUNSPOTS."

X-RAYS

Industry Finds a New Tool—X-Rays. Ind. and Eng. Chem., June 1926, p. 577.

See also "ATOMS."

PROFESSIONAL

General Science Film Program in the Detroit Intermediate Schools. The Educ. Screen, Apr. 1926, p. 205.

The Contribution of Slides and Films to Science Teaching. The Educ. Screen, Apr. 1926.

Methods of Discovery and Removing Specific Causes of Failure in Ninth Grade Science. Sch. Rev., May 1926, p. 373.

The Use of Motion Pictures in the Teaching of High School Science. The Educ. Screen, June 1926, p. 325.

Biological Nature Study—Course of Study Unit, Junior H. S. Jour. of Educ. Meth., Apr. 1926, p. 347.

Mathematics a Useful but Slippery Tool. Sch. Sci. and Math., May 1926, p. 467.

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Garden Magazine. Garden City, N. Y. Monthly. 25c a copy, $3.00 a year. Ill. Helpful to amateur gardeners, teachers and pupils.

General Science Quarterly. Salem, Mass. Quarterly. 40c a copy. 1.50 a year. The only journal published devoted alone to science in the elementary and secondary schools. It tells what schools are doing in science, gives lesson plans, demonstrations, and an extensive bibliography of usable articles in current periodicals.

The Geographical Review. Broadway at 156th Street, New York. Quarterly. $1.25 a copy, $5.00 a year. Devoted to scientific geography. Original maps and piectures. One department contains condensed items of topics of current interest.

The Guide to Nature. Sound Beach, Conn. Monthly. 15c a copy, $1.50 a year. Ill. Of interest to elementary pupils and teachers of nature study.

Hygeia. 535 North Dearborn St., Chicago. Monthly. 25c a copy, $3.00 a year. Popular articles on individual and community health. A valuable supplement to classroom work in hygiene.

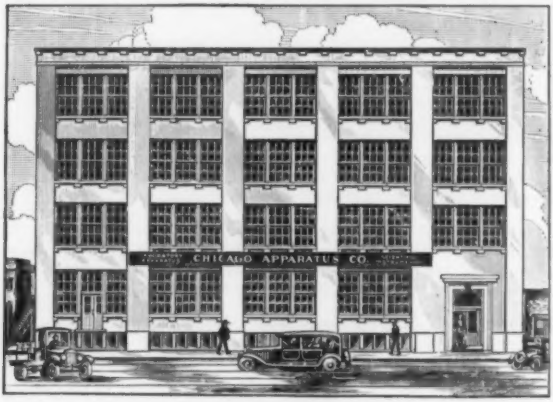
Industrial and Engineering Chemistry. Box 505, Washington, D. C. Monthly. 75c a copy, $7.50 a year. A technical journal which contains much material which teachers can use.

Industrial Education Magazine. Peoria, Illinois. Monthly. $1.50 a year, 25c a copy. An illustrated magazine, which is indispensable to the shop instructor and to others who would "keep up."

Journal of Chemical Education. Easton, Pa. Monthly. $2.00 a year. Promotes chemical education; primarily a journal for the chemistry teacher. Digests of activities of chemical associations.

Journal of the Franklin Institute. Philadelphia, Pa. Monthly. 50c a copy, $6.00 a year. Ill. A technical journal. Contains many articles of value to science teachers.

Journal of Home Economics. 617 Mills Bldg., 700 17th Street N. W., Washington, D. C. Monthly. 25c a copy, $2.50 a year. For teachers.



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